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FRIDAY, NOVEMBER 18, 1910.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

ONE-HUNDRED-AND-FIFTY-SEVENTH SESSION, 1910–1911.

SESSIONAL ARRANGEMENTS.

The Opening Meeting of the One Hundred and Fifty-Seventh Session was held on Wednesday evening, the 16th of November, when an address was delivered by SIR JOHN CAMERON LAMB, C.B., C.M.G., Vice-President and Chairman of the Council. (See pp. 7–15, below.)

PAPERS TO BE READ BEFORE CHRISTMAS.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

NOVEMBER 23.—SIR HENRY H. CUNYNGHAME, K.C.B., "Methods of Detecting Fire-Damp in Mines."
" 30.—CAMPBELL P. OGILVIE, "Argentina from a British Point of View."

DECEMBER 7.—VAUGHAN CORNISH, D.Sc., F.G.S., F.C.S., "The Panama Canal in 1910." Sir William H. White, K.C.B., LL.D., Sc.D., F.R.S., in the Chair.

" 14.—REGINALD A. SMITH, B.A., F.S.A., "A New View of Roman London."

COLONIAL SECTION.

Tuesday afternoon, at 4.30 o'clock:—

NOVEMBER 29.—A. MONTGOMERY, M.A., F.G.S., "The Progress and Prospects of Mining in Western Australia." Admiral Sir Frederick George Denham Bedford, G.C.B., late Governor of Western Australia, in the Chair.

INDIAN SECTION.

Thursday afternoon, at 4.30 o'clock:—

DECEMBER 15.—ROBERT FELLOWES CHISHOLM, F.R.I.B.A., F.S.A., "The Taj Mahal and its Relation to Indian Architecture."

PAPERS TO BE READ AFTER CHRISTMAS.

HORACE M. WYATT, "Motor Transport in Great Britain and the Colonies."
PHILIP JOSEPH HARTOG, M.A., B.Sc., "Examinations and their bearing on National Efficiency."
J. C. MEDD, "The Dutch Labour Colonies."
CYRIL DAVENPORT, "Illuminated Manuscripts."
GEORGE A. STEPHEN, "Modern Machine Bookbinding."
PROFESSOR J. WERTHEIMER, B.Sc., B.A., "Water Finders."
CAPTAIN A. J. N. TREMEARNE, "Some Nigerian Head-hunters."
HON. SIR RICHARD SOLOMON, K.C.B., K.C.M.G., K.C.V.O., K.C., M.A., High Commissioner for the Union of South Africa, "South Africa before and after the Union."
F. DOUGLAS OSBORNE, M.Inst.M.M., "The Tin Resources of the Empire."
REGINALD MURRAY, "Indian Banking."
R. A. LESLIE MOORE, I.C.S. (retd.), "Indian Superstitions."
CAPTAIN R. MUIRHEAD COLLINS, C.M.G., "Australia and her Resources."
FRANK M. ANDREWS, "Architecture in America."
ARTHUR CHARLES DAVIS, F.C.S., Assoc.Inst.C.E., "The Manufacture and Testing of Portland Cement."
GEORGE B. HEMING, "Art Education in Jewellery and Goldsmithing."
COLONEL CHARLES EDWARD CASSAL, V.D., F.I.C., "The Adulteration of Food."
DR. LEONARD HILL, F.R.S., "Caisson Sickness and Compressed Air."

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

January 19, February 9, March 16, April 27, May 25.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

January 31, February 28, April 4, May 9.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "Industrial Pyrometry." Four Lectures. November 21, 28, December 5, 12.

LECTURE I.—NOVEMBER 21.—Early attempts to measure high temperatures. Newton's researches—Wedgwood's pyrometer—Early forms of thermo-electric pyrometers—Modern standards of temperature—Calibration of pyrometers—

Uses of Pyrometers in the manufacture of pottery, glass, iron and steel, coal-gas, etc.—Fusion pyrometers—Calorimetric or water pyrometers.

LECTURE II.—NOVEMBER 28.—Laws of thermo-electricity—Thermo-electric pyrometers of Le Chatelier and Roberts-Austen—Temperature indicators—Recorders, ink and photographic—Arrangement of a number of pyrometers centrally controlled—Determination of the critical points of steel—Application to hardening and tempering—Limits of use.

LECTURE III.—DECEMBER 5.—Laws of resistance to electricity—Siemens' resistance pyrometer—Callendar's pyrometer—Principles of resistance measurement—Temperature indicators for resistance pyrometers—Callendar's recorder—Northrup's recorder—Special uses and limitations of resistance pyrometers.

LECTURE IV.—DECEMBER 12.—Radiant energy—The "fourth-power" law—Laws of Wein and Planck—The Féry radiation pyrometers and indicators—The Holborn-Kurlbaum optical pyrometer—Wanner's pyrometer—Other optical pyrometers—Special uses of radiation pyrometers in pottery manufacture and work at very high temperatures.

FREDERICK WEDMORE, "Etching": 1. "The Old Masters"; 2. "Modern Etching." Two Lectures.

January 23, 30.

PROFESSOR ADRIAN J. BROWN, M.Sc., "Brewing." Four Lectures.

February 6, 13, 20, 27.

PROFESSOR J. A. FLEMING, M.A., D.Sc., F.R.S., "Applications of Electric Heating." Four Lectures.

March 6, 13, 20, 27.

ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal, its Structure and Uses." Four Lectures.

May 1, 8, 15, 22.

JUVENILE LECTURES.

Wednesday afternoons, January 4 and 11, 1911, at 5 o'clock:—

PROFESSOR ARTHUR MASON WORTHINGTON, C.B., M.A., F.R.S., "A Study of Splashes, conducted by the aid of Instantaneous Photography." Two Lectures.

CONVERSAZIONE.

The Annual Conversazione of the Society will be held about the middle of June, 1911. Each member is entitled to a card for himself, and one for a lady.

PROCEEDINGS OF THE SOCIETY.

THE SOCIETY was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom: and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country." In 1908 the Society was granted the privilege of adding "Royal" to its title.

The Session commences in November and ends in June.

Ordinary Meetings.—Meetings are held every Wednesday evening during the Session, at which papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

Indian Section.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session.

Colonial Section.—This Section was formed in 1874 under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies. Four or more Meetings are held during the Session.

Cantor Lectures.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. Several Courses are given during the Session, each Course consisting of two or more Lectures. The Lectures deal with the latest applications of Science and Art to practical purposes, and are, as far as possible, experimentally illustrated.

Howard Lectures.—The bequest of Mr. Thomas Howard (1872) is now devoted to occasional courses of Lectures on motive power and its applications.

Shaw Lectures.—Under the Shaw bequest Lectures on Industrial Hygiene are given from time to time.

Aldred Lecture.—The bequest of the late Dr. Aldred has been devoted to the establishment of an Annual Lecture.

Cobb Lectures.—Funds have been provided for an occasional Lecture in memory of the late Mr. Francis Cobb.

Juvenile Lectures.—A Short Course of Lectures, suited for a Juvenile audience, is delivered to the children of Members during the Christmas holidays.

Admission to Meetings.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted by signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures special tickets are issued.

Journal of the Royal Society of Arts.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures and Commerce.

Examinations.—Examinations, founded in 1853, are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal elements of Commercial Education and Music. Full particulars of the Examinations can be had on application to the Secretary.

Library and Reading-room.—The Library and Reading-room are open to Members, who are also entitled to borrow books.

Conversazioni are held, to which Members are invited, each Member receiving a card for himself and a lady.

Membership.—Candidates for Membership are proposed by Three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council.

The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day preceding election; or a Life Subscription of Twenty Guineas may be paid. There is no Entrance Fee.

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1910–1911. It is issued subject to any necessary alterations :—

NOVEMBER, 1910

1	Tu	
2	W	
3	Th	
4	F	
5	S	
6	S	
7	M	
8	Tu	
9	W	
10	Th	
11	F	
12	S	
13	S	
14	M	
15	Tu	
16	W	Opening Meeting of the Session
17	Th	
18	F	
19	S	
20	S	
21	M	Cantor Lecture I. 1
22	Tu	
23	W	Ordinary Meeting
24	Th	
25	F	
26	S	
27	S	
28	M	Cantor Lecture I. 2
29	Tu	Colonial Section
30	W	Ordinary Meeting

DECEMBER, 1910

1	Th	
2	F	
3	S	
4	S	
5	M	Cantor Lecture I. 3
6	Tu	
7	W	Ordinary Meeting
8	Th	
9	F	
10	S	
11	S	
12	M	Cantor Lecture I. 4
13	Tu	
14	W	Ordinary Meeting
15	Th	Indian Section
16	F	
17	S	
18	S	
19	M	
20	Tu	
21	W	
22	Th	
23	F	
24	S	
25	S	CHRISTMAS DAY
26	M	*Bank Holiday*
27	Tu	*Bank Holiday*
28	W	
29	Th	
30	F	
31	S	

JANUARY, 1911

1	S	
2	M	
3	Tu	
4	W	Juvenile Lecture I.
5	Th	
6	F	
7	S	
8	S	
9	M	
10	Tu	
11	W	Juvenile Lecture II.
12	Th	
13	F	
14	S	
15	S	
16	M	
17	Tu	
18	W	Ordinary Meeting
19	Th	Indian Section
20	F	
21	S	
22	S	
23	M	Cantor Lecture II. 1
24	Tu	
25	W	Ordinary Meeting
26	Th	
27	F	
28	S	
29	S	
30	M	Cantor Lecture II. 2
31	Tu	Colonial Section

FEBRUARY, 1911

1	W	Ordinary Meeting
2	Th	
3	F	
4	S	
5	S	
6	M	Cantor Lecture III. 1
7	Tu	
8	W	Ordinary Meeting
9	Th	Indian Section
10	F	
11	S	
12	S	
13	M	Cantor Lecture III. 2
14	Tu	
15	W	Ordinary Meeting
16	Th	
17	F	
18	S	
19	S	
20	M	Cantor Lecture III. 3
21	Tu	
22	W	Ordinary Meeting
23	Th	
24	F	
25	S	
26	S	
27	M	Cantor Lecture III. 4
28	Tu	Colonial Section

MARCH, 1911

1	W	Ordinary Meeting
2	Th	
3	F	
4	S	
5	S	
6	M	Cantor Lecture IV. 1
7	Tu	
8	W	Ordinary Meeting
9	Th	
10	F	
11	S	
12	S	
13	M	Cantor Lecture IV. 2
14	Tu	
15	W	Ordinary Meeting
16	Th	Indian Section
17	F	
18	S	
19	S	
20	M	Cantor Lecture IV. 3
21	Tu	
22	W	Ordinary Meeting
23	Th	
24	F	
25	S	
26	S	
27	M	Cantor Lecture IV. 4
28	Tu	
29	W	Ordinary Meeting
30	Th	
31	F	

APRIL, 1911

1	S	
2	S	
3	M	
4	Tu	Colonial Section
5	W	Ordinary Meeting
6	Th	
7	F	
8	S	
9	S	
10	M	
11	Tu	
12	W	
13	Th	
14	F	GOOD FRIDAY
15	S	
16	S	EASTER SUNDAY
17	M	*Bank Holiday*
18	Tu	
19	W	
20	Th	
21	F	
22	S	
23	S	
24	M	
25	Tu	
26	W	Ordinary Meeting
27	Th	Indian Section
28	F	
29	S	
30	S	

MAY, 1911

1	M	Cantor Lecture V. 1
2	Tu	
3	W	Ordinary Meeting
4	Th	
5	F	
6	S	
7	S	
8	M	Cantor Lecture V. 2
9	Tu	Colonial Section
10	W	Ordinary Meeting
11	Th	
12	F	
13	S	
14	S	
15	M	Cantor Lecture V. 3
16	Tu	
17	W	Ordinary Meeting
18	Th	
19	F	
20	S	
21	S	
22	M	Cantor Lecture V. 4
23	Tu	
24	W	Ordinary Meeting
25	Th	Indian Section
26	F	
27	S	
28	S	
29	M	
30	Tu	
31	W	Ordinary Meeting

JUNE, 1911

1	Th	
2	F	
3	S	
4	S	WHIT SUNDAY
5	M	*Bank Holiday*
6	Tu	
7	W	
8	Th	
9	F	
10	S	
11	S	
12	M	
13	Tu	
14	W	
15	Th	
16	F	
17	S	
18	S	
19	M	
20	Tu	
21	W	Conversazione
22	Th	
23	F	
24	S	
25	S	
26	M	
27	Tu	
28	W	Annual General Meeting
29	Th	
30	F	

The Cantor Lectures and the Ordinary Meetings will commence at Eight o'clock.

The Meetings of the Indian Section and the Colonial Section will be held at Half-past Four o'clock.

The Annual General Meeting will be held at Four o'clock.

The Juvenile Lectures will be given at Five o'clock.

NOTICES.

"INDUSTRIAL ENGLAND IN 1754."

In accordance with a resolution passed by the Council* the Paper read before the Society on April 20th, 1910, by the Secretary, has now been published in book form, with corrections and additions, under the title "Industrial England in the Middle of the Eighteenth Century." The price of the book is 5s. net, and copies may be obtained of the publisher, Mr. John Murray, Albemarle-street, London, W.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Thursday afternoon, the 10th inst. Present:—

Sir William Lee-Warner, K.C.S.I. (Chairman of the Committee), Sir John Cameron Lamb, C.B., C.M.G. (Chairman of the Council), Sir Arundel T. Arundel, K.C.S.I., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., William Coldstream, B.A., Sir Steyning William Edgerley, K.C.V.O., C.I.E., James Fairbairn Finlay, C.S.I., Krishna Govinda Gupta, C.S.I., Sir Philip Perceval Hutchins, K.C.S.I., Henry Luttman-Johnson, Sir Patrick Playfair, C.I.E., Sir John David Rees, K.C.I.E., M.V.O., M.P., Carmichael Thomas, Thomas H. Thornton, C.S.I., D.C.L., Alexander Falconer Wallace, Sir Raymond West, K.C.I.E., M.A., LL.D., Sir James Wilson, K.C.S.I., with S. Digby, C.I.E. (Secretary of the Section).

PROCEEDINGS OF THE SOCIETY.

FIRST ORDINARY MEETING.

Wednesday, November 16th, 1910; Sir John Cameron Lamb, C.B., C.M.G., Vice-President and Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Aitken, William, 17, Church-street, Dumbarton, N.B.

Anderson, Rev. James Forrester, B.D., B.Sc., B.A., St. John's Presbyterian Church, Port Louis, Mauritius.

Anderson, Robert, 8, Esplanade East, Calcutta, India.

Andrews, Frank M., Metropolitan Building, New York City, U.S.A.

Archibald, Captain James F. J., 1053, Marbridge Building, Herald-square, New York City, and Army and Navy Club, Washington, D.C., U.S.A.

Arnold, Felix, Ph.D., A.B., 824, St. Nicholas-avenue, New York City, U.S.A.

Arnot, David, c/o Messrs. Wilson, Sons & Co., Rio de Janeiro, Brazil.

Barrow, John, 26, Old Broad-street, E.C.

Bethune, J. T., 406, Eastern Townships Bank Building, Montreal, Canada.

Biswas, Jatindra Kumar, M.A., 23, Crematorium-street, Entally, Calcutta, India.

Blair, David Ker, M.I.Mech.E., 11, Grey-street, Wellington, New Zealand.

Blamires, Joseph, Bradley Lodge, Huddersfield.

Brown, Percy, 28, Chowringhee, Calcutta, India.

Burlton, C. H. B., Highmore-house, Hereford.

Chessum, Roland B., Woodbury, Enfield, N., and 7A, South-place, E.C.

Clifford, Charles, Chudleigh, Halfin-road, Rangoon, Burma.

Clutton, Miss Maria, 5, Chester-place, Regent's-park, N.W.

Davidson, David, Station-house, Galashiels, Scotland.

Day, Miss Ruth M., 15, Taviton-street, W.C.

Deb, Atindra Krishna, 4, Shampuker-lane, Calcutta, India.

Dickinson, H. P., 807, Majestic Building, Denver, Colorado, U.S.A.

Duncan, Professor Robert Kennedy, 4715, Wallingford-street, Pittsburgh, Pennsylvania, U.S.A.

Dunnington, Professor Francis P., University of Virginia, Charlotteville, Virginia, U.S.A.

Fauth, J., Messrs. Zaretzky, Bock and Co.'s Rice Mills, Dawbong, Rangoon, Burma.

Ferguson, James R., Rooms 314-315, Birk's Building, Montreal, Canada.

Fripp, R. MacKay, 429, Pender-street West, Vancouver, British Columbia, Canada.

Gage, Professor Simon Henry, Stimson-hall, Cornell University, Ithaca, New York, U.S.A.

Gajjar, Professor T. K., M.A., B.Sc., F.C.S., Techno-Chemical Laboratory, near Girgaum, Tram Terminus, Bombay, India.

Ganguly, Ananda Lal, Khalia P.O., Faridpur District, East Bengal, India.

Garnham, James Coote, 132, Upper Thames-street, E.C., and Holmleigh, 3, Fountayne-road, Stoke Newington, N.

Garrett, Thomas Richard Henry, M.A., c/o Messrs. G. Gillespie and Co., Rangoon, Burma, and 16, Queensland-road, Boscombe, Hants.

Giangirji, Raja Bahadur Narsingirji, Begum Bazaar, Hyderabad, Deccan, India.

Gilbert-Wood, Clarence, 5 and 3, Arundel-street, Strand, W.C., and Bertwood, Wimbledon, S.W.

Gill, George T. S., 37, Lancaster-road, Hampstead, N.W.

Greenwell, George Harold, c/o Messrs. Kilburn, and Co., 4, Fairlie-place, Calcutta, India.

Gregg, William Henry, M.D., 135, Cambridge-place, Brooklyn, New York, U.S.A.

Hazard, Hon. Rowland Gibson, A.M., Holly-house, Peace Dale, Rhode Island, U.S.A.

Hollingsworth, John Burton Lee, D.V.S., M.D.C., 105, Cambridge-street, Ottawa, Canada.

* See Report of the Council, *Journal*, vol. lviii., p. 753.

Horne, Rev. Joseph White, M.A., Ivy-house, High-street, Highgate, N.
Hotson, John Ernest Buttery, I.C.S., Secretariat, Bombay, India.
Huber, E. H., 510, Quincy Building, Denver, Colorado, U.S.A.
Inglis, F. A. S., c/o O. H. McCowan, LL.B., Y.M.C.A., Rangoon, Burma.
Innes, Charles, B.Sc., Assoc.M.Inst.C.E., c/o Messrs. T. Cook and Sons, Rangoon, Burma.
Jacobs, J. Warren, Waynesburg, Pennsylvania, U.S.A.
Katayama, Tokuma, Bureau of Works of the Imperial Household Department, Tokio, Japan.
Keay, Lyle, The Mercantile Bank of India, Calcutta, India.
Knight, Joseph, Southfields, Bury, Lancashire.
Lay, Harry Arthur, 45, Hanley-road, Hornsey-rise, N.
Lee, Professor Edwin, B.S., A.M., M.Sc., Meadville, Penn., U.S.A.
Leggatt, Percy Scott, 15, Marine-parade, Lowestoft.
Levene, Dr. P. A., 230, West 139th Street, New York City, U.S.A.
Lubbock, Hon. John Birkbeck, 15, Lombard-street, E.C.
McBride, James H., M.D., Pasadena, California, U.S.A.
Mead, Marvin Hulst, 382, River-drive, Passaic, New Jersey, U.S.A.
Mitchell, Francis James, Srinagar, Kashmir State, India.
Morris, William Hardwicke Grant, A.M.I.Mech.E., Cairo Water Works, Rod El Farig, Egypt.
Mower, Charles Huson, 147, Queen Victoria-street, E.C., and 14, Lower Berkeley-street, W.
Muthukoya-Thangal, Khan Bahadur P.M., Calicut, India.
Nath, Rai Sahib Dewan Amar, Chief Minister to His Highness the Maharaja, Jammu and Kashmir State, India.
Nichalls, J. Mayne, The Nitrate Railways Co., Ltd., Iquique, Chili, South America.
O'Callaghan, T. P. M., Gauhati, Assam, India.
Peart, Arthur Wellesley, B.A., The Maples, Burlington, Ontario, Canada.
Percy, Norman Crook, Assoc.M.Inst.C.E., Byculla Ironworks, Bombay, India.
Pitt, George Earley, B. ès L., Knutsford, Cadbury-road, Moseley, Worcester.
Poats, Thomas Grayson, Clemson Agricultural College, Clemson College, South Carolina, U.S.A.
Powell, Henry Richard, South Lawn, Bickley, Kent.
Prentice, Thomas Theophilus, Assoc.M.Inst.C.E., Empresa del Agua, Lima, Peru, South America.
Pyne, Herbert Barrington, Assoc.M.Inst.C.E., 370, Calle Cangallo, Buenos Aires, Argentine.
Richards, H. W., Brookside, Beverley-road, Barnes, S.W.
Robinson, James, Assoc.M.Inst.C.E., Bhagalpur, Bengal, India.
Roe, Richard Dartnell Tennant, Assoc.M.Inst.C.E., Sir John Jackson (Chile), Ltd., Ferro Carril Arica La Paz, Arica, Chile, South America.
Rohrer, C. W. G., M.A., M.D., B.Sc., Baltimore, Maryland, U.S.A.
Sahasrabudhe, Rao Sahib Ganesh Nagesh, Ellichpur, Amraoti District, Berar, Central Provinces, India.
Seligmann, Albert, 49, Fitzjohn's-avenue, N.W.
Sharrock, Charles William, Dorincourt, Grays, Essex.
Sheoparshad, Rai Bahadur Lala, Rais and Honorary Magistrate, Chandni Chowk, Delhi, India.
Shukul, Rai Bahadur Pandit Bishun Dutta, Sehora-road (E.I. Railway), Jubbulpore District, Central Provinces, India.
Smeaton, Major Charles Oswald, R.A., United Service Club, Pall Mall, S.W.
Smith, William Charles Ernest, M.Inst.C.E., The Nitrate Railways Co., Iquique, Chile, South America.
Spoor, Stanley M., 59, Chancery Lane, W.C.
Stewart, Captain Thomas, V.D., K.I.H., 1, Thackeray-road, Alipore, Calcutta, India.
Stowell, Herbert, 10, Morley-road, Southport.
Taylor, Edward, 17, Thurleigh-road, Wandsworth-common, S.W.
Watkins, Stephen, Assoc.M.Inst.C.E., Ottoman Railway, Smyrna, Turkey in Asia.
Wills, J. Lainson, F.C.S., 133, Midwood-street, Brooklyn, New York, U.S.A.
Woodhouse, Thomas, Briarcliffe, Wormit, near Dundee.
Yearsley, Walter A., Rosador, St. Anne's-on-Sea, Lancashire.
Zizold, Alfredo, Lima, Peru, South America.

The CHAIRMAN delivered the following—

ADDRESS.

At the outset I desire to express my sense of the honour which my colleagues have conferred on me, and to say that it is only in reliance on their forbearance and kindly support that I can hope to perform the duties of the office to which they have called me.

One of the first of these duties is to deliver an address. It has not been easy for me to choose a subject, because most of the questions in which I am interested are controversial or otherwise unsuitable. There is no necessity to describe the work of last session, as that has been admirably done in the annual report prepared by our secretary; and I do not think that any of our affairs demand special attention—unless it be the inadequacy of this building for the work we have to do in it. The conviction of that inadequacy is growing, and promises soon to overcome any reluctance to leave this time-honoured place, where Dr. Johnson spoke and Goldsmith tried to speak. We must hope that powerful, willing, and influential friends will be found to support

us in any measures we may find it prudent to take with a view to obtain better accommodation.

With regard to the coming session there is promise of an interesting and useful series of papers. Before Christmas Sir Henry Cunynghame, whose competence to deal with the subject is known to all, will read a paper on "Methods of Detecting Fire-Damp in Mines"; and his paper will be followed by papers on "The Progress and Prospects of Mining in Western Australia," "Argentina from a British Point of View," "The Panama Canal in 1910," "A New View of Roman London," and "The Taj Mahal and its Relation to Indian Architecture." For the meetings after Christmas the list already contains twenty-seven papers and lectures, of which I mention one—namely, "Dutch Labour Colonies," by Mr. Medd—because it affords me the occasion to say that six years ago Mr. Medd read a valuable paper here on "Agricultural Education," and I hope he may be induced to read another. The Society has taken a leading part in fostering commercial education, and might take an equally honourable part in promoting the kind of education which would fit the rural population for rural occupations and keep them on the land. It seems scarcely likely that those who have become accustomed to town life will return to the land; but if the young people there, instead of being made into clerks, were trained to become masters and mistresses of the arts and crafts which belong to prosperous village life, they might, perhaps, be induced to stay where they are. The first necessity is a sound public opinion on the subject, and the Society, by giving publicity to such papers as that which was read by Mr. Medd in 1904 may do much towards forming it.

On previous occasions you have had described to you the history and objects of our Society, its relation to other societies, and the part it has taken in bringing some of them into being. Since 1754, when it was founded and became one of a trio with the Royal Society and the Society of Antiquaries, so many societies have come on the scene that you might be pardoned if you thought there could no longer be any necessity to maintain one like ours. The list of other societies in London—I use the word "societies" in its widest sense—does indeed convey the impression that, by the experts in those societies, arts, manufactures and commerce must be completely and exhaustively looked after in all their ramifications. But I venture to say that, so far from rendering ours unnecessary, the existence of such societies increases the need for its maintenance in vigour and efficiency, and calls for strenuous efforts to promote its prosperity. For what do we see in many of them, admirable as they are? We see specialists, working together in their own special sphere, not mingling in their work with the general public or even with other kinds of specialists; we see tests and barriers set up and terms and expressions used which are hard to be understood; we see methods adopted which, however natural and necessary, must tend to the creation of a class or classes apart. The merit of our Society is that it excludes no one, creates no class, sets up no tests, barriers, or distinctions; that it brings specialists and experts of all kinds into fellowship and co-operation, links them with men of affairs, and brings them all and their work into relation with an appreciative public and with the current life of the nation. Surveying the field of human activity it turns to all classes and conditions of men and says, in the words of Pope in his "Essay on Man":—

> Let us . . . .
> Expatiate *free* o'er all this scene of man;
> A mighty maze! but not without a plan;
> . . . .
> *Together* let us beat this ample field,
> Try what the open, what the covert yield.

It is impossible for me, however, to "beat this ample field." I must limit myself to something which will not hold you long; and the suggestion has been made that I should speak to you on "Telegraphs." My old friend and colleague, Sir William Preece, and others, have described and illustrated this subject, and I think they must have told nearly all there is of it in science, in history, or in anecdote. About its administrative side, with which I am more familiar than with any other, many interesting things might, no doubt, be told; but the best of them are highly controversial, and therefore barred. I propose, then, with your permission, to describe how from time to time telegraphs have come within the sphere of our Society. That is a field, I think, which has not been beaten before. I do not propose to carry the description further down than to sixpenny telegrams. After that everything must be well within your recollection. Moreover, by limiting my address in this way, I hope to escape the charge of being tedious, and, in any case, I shall happily avoid the question of the policy of the State in regard to telephones.

The first mention of telegraphs in the Proceedings of the Society was in 1805, when a silver

medal and ten guineas were awarded to Joseph Davis for a "Night and Day Telegraph." It was not an electric telegraph, but a semaphore, with seven shutters for day work and seven lamps for night. Whether it ever came into use I cannot ascertain. The Admiralty were using a semaphore with six shutters; and, eleven years later, they adopted Sir Home Popham's mast with two arms which, in this country, seems to have superseded every other form. In the very year in which they did this, a member of our Society, Mr. (afterwards Sir) Francis Ronalds, was experimenting in his garden at Hammersmith* with an electric telegraph, and he afterwards recorded his success in the following words:—"The result seemed to be that that most extraordinary fluid or agency, electricity, may actually be employed for a more practically useful purpose than the gratification of the philosopher's inquisitive research . . . that it may be compelled to travel . . . many hundred miles beneath our feet . . . Why has no serious trial been made of the qualifications of so diligent a courier? . . . Why should not our Kings hold councils at Brighton with their Ministers in London? . . . Why should our defaulters escape by default of our foggy climate? . . . Let us have electrical conversazione offices, communicating with each other all over the kingdom." But it was not until 1843 that the electric telegraph came before the Society. On the evening of May 17th in that year, "Cooke and Wheatstone's improved practical electric telegraph," as used on the Great Western Railway, was described in this room and illustrated by a complete telegraph at work, the manipulators being two of the young men who were daily working the telegraph on the Blackwall Railway. On the table there were diagrams, specimens of wire, models of winding and drawing apparatus, Cooke's detector for the location of faults, and models of posts. Already there were electric telegraphs on the Manchester and Leeds and Edinburgh and Glasgow Railways, as well as on the Blackwall and the Great Western, and generally they were underground. Cooke's experimental line laid underground from Euston to Camden Town in 1837, often called the "fossil telegraph," was embedded in wood, and later telegraphs were laid in iron tubing; but lofty poles with glass or earthenware insulators were coming into vogue; and the model posts shown on the table represented the beginning of that network of aerial telegraphs which now spreads over the land, imparting a human interest to roads and solitary wastes, and comforting the lonely dweller or traveller with the thought that he is not cut off from his fellow men.

* Ronalds's house here was afterwards occupied by William Morris, the poet.

At this time there was apparently no thought of submarine telegraphy; but a discovery was made which was to become of incalculable value in the manufacture of submarine cables. On March 1st, 1843, Surgeon Montgomerie submitted to the Bengal Medical Board the first specimens of gutta-percha of which there is any historical record. In the summer of the same year he sent specimens to this Society, and the Society's Committee of Chemistry, Colonies and Trade investigated the qualities of the material and took practical steps to bring it into use.

In 1845, the Secretary, Mr. Whishaw, having read here a paper describing it and shown articles which he himself had made out of it, Dr. Montgomerie was awarded the gold medal of the Society in recognition of the great importance of his discovery. The work of the Society led directly to the importation of gutta-percha as an article of commerce, and to its being shown at the Great Exhibition of 1851. Not only so, but it led to its being used for the insulation of telegraphs, for it was here, on the occasion of Mr. Whishaw's paper, that Mr. William Siemens heard of the newly-discovered substance and obtained pieces of it for transmission to his brother, Werner Siemens, of Berlin, who was the first to show how it could be used for covering telegraph wires.

In 1851 a Mr. George Little described an improved double-needle instrument, in which the needles were not pivoted in the middle, but were suspended from what he called a "reservoir of magnetism."

Then nothing happened so far as the Society was concerned until February, 1853, when a project for a new telegraph to the Continent was brought before the Society. The brothers Brett had in 1851 laid the first submarine cable of the world between Dover and Calais, and cables had subsequently been laid to Ireland and Belgium, as well as for short distances elsewhere. A company, called the International Telegraph Company, was now formed, "with the view of constructing a submarine telegraph" to Holland. There were to be six conductors and they were to be laid from Lowestoft to Scheveningen. The description given to the Society proceeded as follows:—

"In all former submarine cables, where it was intended to employ several wires, they have been collected together under one coating of stout iron wire, the whole, when completed, bearing the

appearance of an iron rope, of a diameter varying from 1½ ins. to 2 ins. In the present instance the distance to be crossed is so great, that an entire cable, containing the six wires it is proposed to lay down, would weigh above 1,400 tons, which would cause much inconvenience in the operation of laying down. From this and other reasons, the Company's engineer, Mr. Edwin Clarke, has been induced to adopt a new system, and form each wire into a distinct cable by itself; thus between England and Holland there will be laid six independent submarine cables, each of them containing one wire. The advantage of this method in the case of any accident is great, as the faulty rope can be immediately recognised, and overhauled and repaired with facility, which, with a heavier line, if possible at all, would certainly be an operation of considerable difficulty and time. These six cables will be laid down in succession, one after the other, during the ensuing spring. The last four or five miles on either side, being the portion most subjected to danger, will consist of a compound cable, composed of six strands of the single wire cable twisted into one, the strength and weight of which—twelve tons per mile—will act as a safeguard against vessels inadvertently anchoring on the line, or any mischief that may be attempted."

The project was duly carried out, with this modification however, that only four separate "ropes" or cables were laid. A promise was made that a detailed account of the work should be presented to the Society, but the promise was never performed. People do not like to record their failures, and this was a failure. The cables had a curious later history. To a large extent they were recovered from the bottom of the sea, repaired, made up into heavy cables of from four to seven conductors and used again. In 1862 four pieces were twisted together and laid as one cable in Milford Haven and seven were laid across Waterford Harbour, while four years later six were twisted round a central core of indiarubber-covered wire and made into a cable with seven conductors, which was laid from Portpatrick to Whitehead, a distance of twenty-three nautical miles.

In June of 1853 the Society published a communication describing the labours of that great pioneer of telegraphy, Dr. O'Shaughnessy, in promoting, under the sanction and encouragement of the Governor-General and Court of Directors, a wide and rapid development of telegraphs in British India, and showing India in the van of progress with a State system of telegraphic communication.

This was also a year of hope—but only of hope—for direct telegraphic communication with America. In view of the difficulty of telegraphing through a long cable it had been proposed to reach that continent by a series of cables starting from Scotland and extending to the Orkneys and Shetlands, and thence to the Faroe Isles, Iceland, Greenland, and Labrador. When this proposal for some reason fell through, it was reported to the Society, on the authority of Robert Stephenson, the engineer, that, after all, a direct cable might be successful if it were furnished with two conductors forming a metallic circuit. This was hailed by the Society as giving promise of "oceanic telegraphs encircling the whole earth and bringing all parts of it into instantaneous communication with each other." But, as you know, there were many disappointments in store: the metallic circuit across the Atlantic was not tried; the attempts to establish telegraphic communication with America in 1857, 1858, and 1865, all in one way or another came to nothing; and not until 1866 was success achieved. So far as I am aware, metallic circuits were never used in submarine cables until they were adopted in 1891 for the telephone service to Paris.

The year 1853 saw wireless telegraphy brought before the Society. This was in a note describing the experiments of Mr. Lindsay, of Dundee, a teacher of mathematics, who delivered lectures in Glasgow, and showed how the electric telegraph could be worked through a wireless gap with water as the conducting medium. This, you will see, was wireless telegraphy, but very different from the wireless telegraphy of to-day.

In March, 1857, the Society was informed of an instrument invented by Dr. Bernstein, of Berlin, by which two messages could be telegraphed simultaneously on the same wire; and this was probably the origin of "diplex," if not of "duplex," telegraphy.

In October of the same year the Society published extracts from a letter of Professor Morse and the official reports of Mr. (afterwards Sir) Charles Bright, describing the breaking of the first Atlantic cable as it was being paid out from the United States frigate *Niagara*. This failure and a failure in the Mediterranean led a Mr. De la Haye to propose a new method of submerging deep-sea cables. As described in our *Journal* of October 27th, 1857, his proposal was that the cable should be coated with a soluble compound which would keep it floating for a time on the surface of the water. He calculated that about five miles of cable could always be held up by this means in the wake of the cable ship, and he thought that, as the compound dissolved, the cable would gradually descend in an almost horizontal position instead of in a nearly

vertical one. In this way liability to break would be reduced to a minimum. There is no record of a trial of Mr. De la Haye's plan, or explanation of the means by which he proposed to make the soluble compound adhere evenly and keep its place when the cable was coiled in the hold or when, with several turns round the cable drum, it was paid out over the cable sheaves.

A plan for connecting the police and fire-brigade stations in London by the electric telegraph was brought before the Society in December, 1857, by Mr. (afterwards Sir) Sydney Waterlow. He was well qualified to offer advice, not only because of his practical interest in everything affecting the comfort and safety of the public, but because he had already caused the three business premises of his firm, in Birchin Lane, London Wall, and Parliament Street, to be connected by private wires, and had proved how greatly they facilitated business and what a saving in time and labour they brought about.

On April 21st, 1858, Mr. (afterwards Sir) William Siemens read an important paper on "The Progress of the Electric Telegraph" from the earliest times. Mr. (afterwards Sir) William Grove, Q.C., who became celebrated as a judge and as a man of science, was in the chair, and there was an animated discussion in which Mr. Highton (the inventor of the Highton single-needle instrument) and Mr. Varley took part. Mr. Siemens mentioned the work in 1728 of Stephen Gray, a pensioner of the Charter House; of Lesage, of Geneva; of Lomond, the Frenchman; of Galvani and Volta; of Oersted, Faraday, Ampère, and Morse; of Gauss and Weber; and of Cooke and Wheatstone. He discussed the use of gutta-percha as an insulating material and gave his opinion as to the best design to adopt for submarine cables; prophesied the supersession of double and single-needles by Morse printers, and a general reversion to underground telegraphs; and hinted at a possible use of aluminium, instead of copper, for the conductors of deep-sea cables. At that time there was no inkling that Morse printers themselves would be superseded by Morse sounders—one of the most remarkable developments from complication to simplicity that has ever been seen—or that insulation by a combination of air and paper would come into use, a form of insulation which alone has rendered feasible a wide resort to underground telegraphs. As to the conductors of deep-sea cables, copper, as you all know, still holds the field. In the time at our disposal it is impossible to go further through the details of this able paper; but those of you who have watched the working of a modern single-needle instrument may be interested to learn that the needle of Gauss and Weber, which Mr. Siemens saw when he was a student at Göttingen in 1833, weighed 100 lbs., was suspended by silk from the ceiling, and had to be observed—for its delicate movements to the right or to the left—through a telescope. In the discussion Mr. Highton foreshadowed that system of codes which has caused not a little anxiety to submarine cable companies from time to time. He declared that he had already devised a code of his own. What it was I do not pretend to understand; he said it contained "800,000,000 times 2,000,000 preconcerted messages," and that the messages "did not occupy one side of half a sheet of foolscap, and each would not occupy more than twelve seconds in transmission." Truly a case of *multum in parvo.*

There was a memorable meeting here on April 13th, 1859, when a paper was read describing the printing telegraph of Professor David Hughes, and a method he had devised to cure cracks in the gutta-percha of submarine cables by a viscous fluid which was to be applied to the copper conductor, and was to ooze automatically through the cracks and harden. This method came to nothing, but the printing telegraph conquered Europe, and still holds sway as one of the most efficient instruments in daily use. What a meeting to stir the pulse of a telegraph man! In the chair sat William Fothergill Cooke; among the men present and admitted that night to membership for the first time was Cromwell Fleetwood Varley; and beside him was the genial Hughes himself, who was to add to his laurels at a later date by inventing the microphone.

I trust you will not blame me for having lingered over these early days. I will now proceed at a more rapid rate.

Land telegraphs had been gradually spreading over the civilised parts of the world, and schemes of submarine telegraphy were multiplying. The *Journals* of the Society presented reports and discussions on the making, laying, and repairing of submarine cables, on the types of cable best adapted to particular cases, and on the instruments which might be used to overcome the difficulties experienced on long lines of communication. They furnished information on home, foreign, and colonial telegraph systems, and gave statistics of their growth; they gave to the world the Cantor lectures of Professor Fleeming Jenkin; they recorded the founding of the International Telegraph Union, whose object it was

to bring the telegraph administrations and companies of the world into harmonious co-operation, and to settle the terms and conditions on which they could carry on the business of international telegraphy—a Union, I may remark, which was the prerunner of the International Postal Union founded in 1874. With the exception of North America and the British Isles every country using the telegraph had placed it under government management—sometimes in conjunction with the post office and sometimes independently. In this country the question was now being publicly mooted whether it was not time that the State should buy up the undertakings of the telegraph companies, and Mr. (afterwards Sir) Edwin Chadwick, that man of untiring energy, took the lead as a member of this Society in forcing the question to an issue. Whenever a real reform affecting a government department is beginning to recommend itself to the public they may feel pretty sure that some civil servants are already at work on it behind the scenes. So it was in this case; Mr. F. I. Scudamore and Mr. F. E. Baines were at work within the walls of the Post Office. In his report presented to Parliament, Mr. Scudamore testified that as early as 1856 Mr. Baines had proposed the transfer of the telegraphs to the State; and declared that, although his proposals were not first in order of date—a Mr. Allan having made proposals in 1854—yet "they were the first which contained any practical suggestions as to the mode in which the transfer might be effected, any distinct practical statement of the advantages which might be expected to accrue from it, or any reliable data in support of the arguments advanced." This does not detract from the merit or interest of Mr. Chadwick's work, and I have no doubt that Mr. Scudamore and Mr. Baines rejoiced that such a man should be working in the same direction as themselves. On more than one occasion in later days it is certain that an officer of the Post Office would have hailed the help of a man like Chadwick and of a disinterested body like the Council of this Society. Mr. Chadwick's paper here on February 27th, 1867, had a powerful effect on public opinion and helped materially to pave the way for the telegraph legislation of 1868. He showed the advantage of concentrating in the hands of one authority the undertakings of the various companies, which, in many places, had rival offices almost side by side, but practically no facilities in the villages; which planted two or more lines of poles on a road where one would have sufficed for the requirements of the public; which charged porterage on a large proportion of the telegrams delivered, and carried the telegraph into no locality unless there was a prospect of business sufficient to pay for the rent of an office, for light and firing, for a telegraphist and for messengers. He pointed out that the Post Office had an immense number of offices already open for postal business, and that telegraph business could be transacted in such offices at less cost than in offices specially established for the purpose; that a Department of the State ought to be able to procure wayleave for its poles and wires on less onerous conditions than a private company trading for profit; that the expansion of the system which would result from its being placed under public control would foster trade and commerce, add to the comfort and security of the public, and make life in country places more tolerable and more profitable. He had well in view the subject of porterage, intimately connected as it was with delay to the messages. The charge for telegraphing a message from London to Ham, where Mr. Chadwick lived, was one shilling, but eighteenpence had always to be paid for delivery; therefore the message was delayed and the real charge was half-a-crown. All over the country there were not only cases like this, but cases much worse. How different the situation is now we all know. The only criticism, I think, to which the paper was open is that it was too sanguine with regard to the financial results of a transfer to the State. Mr. Chadwick did not sufficiently gauge the power of the railway companies, or the determination of Parliament to improve the conditions of service of the employees, while at the same time demanding ever-expanding facilities. The public cannot have it both ways; they can have a balance on the right side expressed in the manner familiar to accountants if they direct their administrators to conduct the business on commercial principles, but if they prefer to have facilities at any cost they must be content to see financial deficits. They do after all get a balance on the right side, but it is expressed in facilities and not in Arabic figures. The meeting was remarkable for a speech delivered by Mr. Scudamore himself—a speech which Mr. Chadwick described as "complete and satisfactory."

Before we pass from the year 1867 it may be well to mention that the Society's Albert medal was awarded in that year to William Fothergill Cooke and Charles Wheatstone. It seems specially appropriate that the Society should have rewarded those great inventors at the very time when it was itself taking so prominent a part in

bringing about a wide expansion of the system which they had placed at the disposal of the public.

Mr. Chadwick did not rest. In the following year he contributed to the *Journal* of the Society some powerful letters in support of the policy of transferring the telegraphs to the State; and there can be little doubt that by the publicity which it gave to these letters, as well as to the paper which Mr. Chadwick read here, the Society helped to overcome opposition and to educate public opinion. In the same year (1868) an Act was passed authorising the Postmaster-General to buy up the undertakings of the telegraph companies, and Mr. Chadwick and the Society were satisfied for the time; but the Act of the following year (1869), which conferred a monopoly on the Postmaster-General, stirred the Society afresh, and it appointed a special committee to watch the Post Office and keep it up to the mark. Apparently the work of this committee was not very arduous. In 1872 the Council of the Society broke fresh ground and began a course of pressure, which they continued for several years, in favour of the purchase of the "ocean telegraphs" and the consolidation of "the same with the internal telegraph service under the management of the Post Office." Their views were well expressed in a memorial addressed to Mr. Gladstone, who was then Prime Minister, and the memorial was followed by a letter in which the Council showed their confidence in Mr. Scudamore by proposing that he should be directed to examine the question and prepare a report for the consideration of Government. A favourable result was not possible. The telegraph department had its hands full with the management of the internal service; while to carry out the provisions of the Telegraph Acts, which left the external telegraphs outside the Postmaster-General's monopoly, it had made agreements with certain companies from which it could not set itself free. When in 1889 these agreements were approaching expiry the department lost no time in arranging with the entirely friendly Administrations of France, Belgium, Holland, and Germany for the joint ownership, joint maintenance, and joint working in each case of the cables from this country, giving effect thus far to the views of the Society. These cables were practically frontier telegraphs involving no serious international difficulties. The case was very different with the long cables touching the territories of various foreign Powers. Here the cable companies had an advantage over any State administration. They were allowed to establish offices of their own and thus to secure unity of management from end to end. No State administration could expect to be permitted to have offices and employees on foreign territory. With the frontier telegraphs an intermediate company was an obstruction; but, in the case of the long cables touching various countries, a company conferred a benefit on the public and on commerce by its singleness of system and control. The subject is too large to discuss this evening, but I mention it in order to explain that the policy recommended by the Society had relation, consciously or unconsciously, to two different cases, one complicated and controversial and the other clear and non-controversial, and that when the latter—the frontier telegraph case—came within range it was dealt with by the Post Office in a practical manner without delay.

The Society had done well, and had helped to bring about a result the importance of which it would be difficult to exaggerate. Not only was the internal system of telegraphs cheapened and expanded so as to facilitate home business in all directions, but the way was prepared for the direct management and working of the telegraphs to neighbouring States; British capital was released for investment in submarine cables; experienced British administrators were set free to devote themselves to the management of great telegraph undertakings; and the manufacture of cables by British firms was encouraged and set on an almost unassailable basis. In helping to promote the transfer of the inland telegraphs to the State the Society had done more than appeared on the surface. Submarine telegraphy was awaiting development; courageous and able pioneers had entered that field, but more capital was required and the aid of experienced administrators. By the transfer to the State both were made available, and the position which Nature and the enterprise of her people had given to this country was seized with firm hands, was defended, confirmed, and strengthened; and in a comparatively short time the United Kingdom was presented to the world as the absolute centre of telegraphic communication.

If the position has in recent times been to any degree weakened it is not the fault of the men to whom I have referred, or of their successors. Nor is it the fault of this Society.

In 1879 Sir William Preece delivered here a series of six Cantor lectures on "Recent Advances in Telegraphy"; and by the clearness and simplicity of his explanations and the success of his experiments made the subject plain to the least scientific mind. By means of these

lectures the Society performed a fresh service to the public in stimulating interest in a subject which was more and more affecting the comfort and prosperity of the nation.

Mr. Chadwick and the Society had expected that when the telegraphs were acquired by the State, the charge for an inland telegram would be reduced to 6*d*., and the same expectation was entertained by the reformers within the Post Office. But time and thought showed that it was too much to achieve at once with the means then available. The volume of additional work which it would have thrown on a new department would have been too great. The plant acquired from the companies had to be put in order, fresh lines of telegraph had to be constructed, more office accommodation had to be provided, the employees of separate companies had to be welded together and organised anew, and an administrative staff had to be trained. The Society in a judicious manner kept the subject alive, and when the time for action came it acted promptly and in such wise as to secure the friendly appreciation of the Post Office; so much so that the two may be said to have been in co-operation. It is remarkable how on this occasion again the minds of your Council were working in the same direction as the minds of the Post Office authorities. Although not seeking to dictate to the department, and prepared to learn that other plans might have something to recommend them, your Council made a suggestion only to find that it was in entire harmony with the views of the Post Office. What took place was this: A petition was carefully drawn up and transmitted to the Postmaster-General at the beginning of July, 1880. It was in the following terms:—

To The Right Honourable Henry Fawcett, M.P., Her Majesty's Postmaster-General.

The Memorial of the Council of the Society for the Encouragement of Arts, Manufactures, and Commerce

Respectfully Sheweth,—

That the Council are strongly of opinion that the time has now arrived when the charge on inland telegrams might be reduced, and a minimum charge of sixpence substituted for the present one of a shilling.

They submit that the charges on inland telegrams in this country are higher than in other European countries, the rates in France, Germany, Belgium, and Switzerland, all being lower than in England. It is even a curious anomaly that a telegram can be sent from any part of the United Kingdom to Belgium or to France for less than the smallest sum for which a telegram may be sent from one part of London to another.

The Council do not propose to make any suggestions as to the details of the method by which the reduction of charge should be effected; whether by employing a lower tariff within certain limited districts, such as the Metropolis and its suburbs, or the country within a certain radius of a provincial town; or, secondly, by adopting a word-tariff, with a minimum charge of 6*d*. The precise details are, the Council feel, safely to be left to the department itself.

They feel sure, however, that a reduction in the tariff would be accepted as a boon by a large number of those who are prevented, by the present rates, from using the telegraph as largely as they would wish, and that the business of the department would soon be so increased as to fully compensate for the lessened revenue which might be the first consequence of the proposed change.

(Signed)

Alfred S. Churchill, Chairman of the Council.

H. T. Wood, Secretary.

On the 17th of the same month a deputation from the Council attended at the General Post Office to support the petition. Lord Alfred Churchill, late Chairman of Council, introduced the deputation, and was followed by Mr. Chadwick. The Postmaster-General, Mr. Fawcett, was accompanied by several of the principal officials of the Post Office, including the Assistant Secretary for Telegraphs, Mr. Charles Patey, whose services, alas! were so soon to be lost to the State through his early death. After listening to the able arguments of Mr. Chadwick, Mr. Fawcett made a long, closely-reasoned and sympathetic reply. He declared emphatically for the second plan mentioned in the petition—viz., a word-tariff with a minimum charge of 6*d*.; he scouted the suggestion which had reached him that there should be two classes of telegrams, immediate and deferred; he showed how little would be saved for the Exchequer by limiting the reduced charge to certain towns and districts; and he expressed a firm opinion in favour of a uniform charge throughout the United Kingdom. While warning the deputation that the question was one the settlement of which must depend on the Chancellor of the Exchequer, he frankly placed before them estimates showing at what a moderate cost the change could be carried out, and left no doubt in their minds that he himself and the officials of the Post Office were on their side. But, as you know, a long delay was to intervene between promise and fulfilment, and obstacle after obstacle had to be surmounted; Mr. Fawcett did not live to send a sixpenny

telegram; a private member had to carry a resolution against the Government of the day before any practical step was taken; and it was not until October 1st, 1885, that the long-desired change was brought about.

In this inadequate review I have endeavoured to show you what has been the conduct of your Society in relation to telegraphs down to comparatively recent times. You have seen it encouraging a new invention, giving facilities for the demonstration of its importance and usefulness, recording and publishing its every advance, and helping Parliament and successive Governments to arrive at just conclusions with regard to it. You have seen your Society taking a leading and enlightened part in procuring the transfer of the inland telegraphs to the State, in promoting the purchase and direct working of the cables to the Continent, and in bringing about the introduction on a sound plan of sixpenny telegrams. You have seen it successful because, above all things, it was disinterested. I see no limit to the influence which enlightened men may bring to bear on the public and on public authorities if they are not actuated by selfish motives. May unselfishness always remain the characteristic of this Society, and may success continue to attend its efforts on behalf of humanity.

After delivering the Address, the Chairman presented the Society's medals which were awarded for papers read during last Session.

At the Ordinary Meetings:—

To Mr. T. Thorne Baker, F.R.P.S., for his paper on "Telegraphing Pictures."

To Mr. H. Pearson, for his paper on "The Diamond Fields of Brazil."

To Count Hirokichi Mutsu, C.V.O., Imperial Japanese Government Commissioner, for his paper on "The Japan-British Exhibition, 1910."

To Mr. Omar Ramsden, for his paper on "Silversmiths' and Goldsmiths' Work."

To Mr. Charles John Stewart (Public Trustee), for his paper on "The Public Trustee and his Work."

To Sir William Crawford, J.P., for his paper on "Irish Linen and Some Features of its Production."

To Mr. Sydney Perks, F.R.I.B.A., F.S.A., for his paper on "The Restoration and Discoveries at the Guildhall, London."

In the Indian Section:—

To Sir James Wilson, K.C.S.I., for his paper on "The Punjab."

To Mr. Saint-Hill Eardley-Wilmot, C.I.E., for his paper on "Indian State Forestry."

To Mr. J. Claude White, C.I.E., for his paper on "The Arts and Crafts of Tibet and the Eastern Himalayas."

In the Colonial Section:—

To the Hon. John McCall, M.D., Agent-General for Tasmania, for his paper on "Fruit Production in the British Empire."

Sir William H. White, K.C.B., in proposing a hearty vote of thanks to the Chairman for his Address, said that Sir John had in considerable detail and in a most interesting manner, traced the work the Society had done in furthering the introduction of telegraphic communication. The Chairman had quoted largely from the Proceedings of the Society, but he (Sir William White) did not think anyone could have produced the Address except Sir John, because he had knowledge, not merely of the Proceedings of the Society, but inside knowledge of the department where he played so important a part for so long a time; otherwise he could not have produced such a very interesting and complete history of events. He was sure all present would agree that they would have been delighted if Sir John had felt himself free to enter into controversial matters. He came very near doing so on one or two occasions, but he was so marvellously discreet that he always escaped over the thinnest ice, and came back to the firm ground of the Society. He (Sir William) assured the Chairman that all the members were deeply indebted to him for the labour he must have bestowed on the preparation of the Address, which would be a record to which reference would be made in the future as the authentic and authoritative statement of what had happened in the great improvement in public communications to which the Address referred. He thought the members would also agree that Sir John had sketched in a very clear and comprehensive manner the justification for the continued existence of the Society. He had, however, not drawn attention to one of its many advantages, of which the Chairman, Sir Steuart Bayley, and himself were illustrations—viz., that it was a refuge for destitute and retired public servants. When retired public servants ceased to be the victims of official control they came to the Royal Society of Arts, and sometimes became controversial.

Sir Steuart Colvin Bayley, K.C.S.I., in seconding the motion, said the Society greatly appreciated the honour of having a distinguished public servant like Sir John to succeed the late chairman, Sir William White. The Paper on Lifeboats which the Chairman gave to the Society a few months ago introduced the members to his admirable capacity for informing them on subjects in which they might not only take an interest but to which they gave serious assistance

The praise which Sir William White had bestowed upon the Chairman's discretion would be echoed by all present, but he was sure they would sometimes be very glad to dispense with it.

The resolution of thanks was then put, and carried with acclamation.

The CHAIRMAN, in reply, thanked the mover and seconder for the very kind words they had used, and the audience for the extremely cordial manner in which it had received them.

THE TRADE OF INDIA FOR 1909-10.

The Review of the Trade of India for the official year ending March 31st last has just reached England. It is written by Mr. C. W. E. Cotton, I.C.S., Officiating Director-General of Commercial Intelligence, and marks in almost every respect an appreciable advance upon the statistics for the preceding twelvemonth, which had revealed a deplorable weakness in almost every direction. The import market had been glutted, food grains had attained high prices, and there had been a general feeling of insecurity created by the slow recovery of credit in Europe and America, the consequence being that such small improvement as was manifested was scarcely perceptible in any of the trade returns. The figures for 1909-10 have thus proved the year to be one of recuperation rather than development, and, although all unhealthy symptoms have not yet disappeared, Mr. Cotton considers that "India, after an unusually prolonged period of trade sickness, may be regarded as almost convalescent."

There was a marked improvement in foreign trade at the beginning of the year under review. During the calendar year 1909 there had been considerable advances in the total value of imports into the United Kingdom, France, Germany, Belgium and the United States, and in all except the last the sum of the exports is considerably higher. The Indian monsoon rains in 1909 were exceptionally favourable, and the increase in total estimated out-turn exceeded 14 per cent. in the case of jute, 22 per cent. in the case of cotton, 26 per cent. in that of wheat, 43 per cent. in rice, and 24 and 44 per cent. in the two chief descriptions of oil seeds.

Regarded as a whole the export trade was unusually active, particularly in the last four months of the year, and the high prices of wheat, cotton and oil seeds not only directly benefited the cultivators in almost every province, but served to replenish automatically the stocks of gold in the country which had been diminished by abnormal imports and the American banking crisis. In the matter of imports, too, the record is also somewhat unsatisfactory, as in all those lines which are regarded as indices of returning industrial activity the recovery has been only partial and incomplete. The value of metals and manufactures, and all kinds of machinery, has again fallen, the railway indents were smaller, and the increasing imports of sugar from the Dutch Indies, in spite of the rise in prices, are hardly matters for congratulation, when it is considered that the acreage under cane in India largely exceeds that of any other country in the world.

As for the future, Mr. Cotton considers that further trade improvement is probable during the next twelve months in Europe and America, but that for India the restoration of industrial activity and the development of those internal exchanges which have been so conspicuously in defect during the last three years, can only be assured by a continuance of general agricultural prosperity.

Without attempting to review the detailed heads, which would occupy far too much space, one may notice here some of the more characteristic features in the year's imports. In regard to sugar, the twelvemonth was marked by a steady rise in prices due to a general shortage of the beet crop as a result of bad weather on the Continent, which increased production in Cuba, the West Indies and Java was not expected to make good. Ten years ago, before the Brussels Convention and the abolition of the bounty system, the production of beet sugar was about double that of cane, but in 1909 it is calculated that the cane crops of the world amounted to about eight million tons, excluding India, as compared with about six million tons of beet. The combined total is below the world's estimated annual consumption of 14½ million tons, and thus proved insufficient. The imports into India of sugar of both kinds rose by about 4·4 per cent. in quantity, and 5½ per cent. in value. The chief sources of supply of cane sugar continue to be Java and Mauritius, while in beet sugar Austria-Hungary continues to retain the dominant place. In regard to India's own potentialities as a sugar producer these are hampered by a variety of circumstances, including the difficulty of concentrating cultivation round central factories and the fact of the demand being practically restricted to molasses and low-grade sugar, produced by wasteful and primitive methods.

In the imports of mineral oil there was a noticeable decline. Mr. Cotton remarks that the discovery of oil at Maikop (in the Caucasus), the successful proving of the Red Sea oil-field and the conflict of interests in Mexico between the Pearson and Waters Pierce groups, temporarily made the industry a speculative medium on the London Stock Exchange only less active than rubber, and this activity found a parallel in Burma, where during the last two years no fewer than seven new companies have been floated.

The imports of coal, which represented 17·2 per cent. of the value of raw materials imported into India twelve months ago, fell to 15·1 per cent., this being due apparently to restricted industrial activity in several branches of trade.

Cotton goods maintain their position of preponderance among imports of manufactured

articles, and on the average of the past three years constitute about 34 per cent. of the total values of all imports. In the year under review, however, cotton in the Western markets continued in a state of great depression, spinners and manufacturers alike being affected by discouraging and irregular demand and an extraordinarily narrow margin between the prices of the raw material and those of the finished products. In yarn there was a decline in the year's figures, but cotton fabrics rose in value, and of these the proportions supplied by Great Britain were as follows:—grey goods 99 per cent., whites 98 per cent., and coloured goods 93½ per cent. of the total. The prices of silk goods imported fell, owing partly to the large out-turn of raw silk in China and partly to a falling off in the American demand, and in spite of the shortage in Continental supplies caused by the destruction of the silk filatures in the Messina earthquake. Business in French and Italian silk fabrics was dull throughout the year and this reacted on the Indian trade. In the imports of woollen manufactures into India there was a considerable setback due to trade depression and the legacy of large stocks which heavy speculative purchasers of the previous two years had bequeathed.

The most interesting features of the list of Indian exports, which show advances in most cases, are the high percentages of increases under wheat and wheat flour, pulses and millets, seeds, cotton raw and wool raw, while the only noticeable decreases are under jute raw, indigo and coffee.

As regards rice, there was an unusually good crop in Burma and the two Bengals, some shortage in southern India, a further advance in foreign exports and a slightly lower range of prices. The lower prices for jute encouraged increased acreage under rice in the two Bengals. Ceylon continues the largest single purchaser of Indian rice, the exports to the Straits Settlements rose considerably, while of the western countries Germany is the most important consumer. The United Kingdom and Austria-Hungary also took larger shares.

The Indian tea trade continues its career of prosperity, and prices were maintained at an unusually steady level, the average price of tea sold at Calcutta auctions marking an advance of 13 per cent. over last year's figures. The proportion of the trade which goes to Russia is of growing interest and importance. The demand in this case includes all grades, and the bulk of the shipments go *via* Colombo and Vladivostock and thence by Trans-Siberian Railway. The exports to Australia during the last two years have decreased, but those for Canada and the United States show a satisfactory increase in spite of the disorganisation of the trade caused by rumours of a proposed import tax on tea entering the United States. The exports of metals and manufactures thereof still occupy a very modest position, representing less than 1 per cent. of the total imports. Manganese ore is the only item of importance, the value having increased from £388,400 to £738,000 in the past five years. Under the small but interesting head of Chinchona bark, we note that the exports have not yet made good the decline recorded in 1908-9, but in spite of the competition of Java bark, which is said to yield a higher percentage of sulphate, the specific value has advanced. It mostly goes from Madras to the United Kingdom.

The export trade in coal continues exceedingly unenterprising, and even the dislocation caused by the prolonged strike in Australia was not taken full advantage of, the quality of some of the coal shipped being so bad as seriously to prejudice further demand. The production of Indian coal in 1909 is estimated at 11,870,114 tons, as against 12,769,635 tons in 1908. A railway test made during the year under review with shipments of first-class Bengal coal, of Natal coal, and of Australian coal, gave the following result:—Bengal coal ran 26 lbs. per train mile; Natal, 27 lbs. per train mile; and Australian, 30 lbs. per train mile.

On the average of three years ending 1908-9 raw cotton represented 30 per cent. of the total value of raw materials exported from India. In 1909-10 the proportion rose to the extraordinary figure of 37½ per cent. In fact, raw cotton supplanted raw jute as the most important single article of exportation.

The world's wool trade has recovered more quickly than the cotton trade from the results of the American panic in 1907. The cost of both raw material and manufacture has risen, as the result of increased consumption on the Continent and a particularly strong American demand.

Under the head of "Articles manufactured and partly manufactured," jute products continue to fill a very prominent place in the export of Indian manufactures. In the year under review their percentage of this rose from 43 to 44·9 per cent. in value, though there was a heavy fall alike in the price of the raw material and the mill products. Cotton manufactures represented 31·3 per cent. of the total value of Indian manufactures exported and 6·5 per cent. of the whole export trade.

The trade of India according to countries reveals some interesting features. The United Kingdom of course heads the list, and the total value of her trade rose in value from 75 to 81 million pounds sterling, but her aggregate share in the total trade fell from 41·1 to 40·2 per cent., this being due to a considerable increase of Indian exports to foreign countries, notably to Java and the United States. The order in which the principal foreign countries rank is thus:—Germany, China, United States, Japan, Belgium, France, Java and Austria-Hungary. Germany, the first of these, owns 7·2 per cent. of the total trade and the new system of registration which notes the ultimate instead of the immediate destination of exports, will further confirm this predominance.

Lastly, it may be noted that while the net imports of silver fell off very considerably, the imports of gold exceeded 16¾ million pounds sterling, the highest total ever recorded. This is no doubt in a sense a measure of the general revival of trade, which is further reflected in an increase of 7·7 per cent. in the aggregate tonnage entering and clearing at Indian ports over the figures for 1908-09.

HOTEL SCHOOLS ON THE CONTINENT.

The business of conducting a first-class hotel has developed into such an international character, and requires such wide scope of training and knowledge, that on the Continent steps are being taken for the establishment of schools to furnish this special training. In Switzerland such a school has been in operation for years. The prevailing method of training young men for this business in Switzerland is to send them to the large hotels in foreign countries, where foreign languages and customs may be learnt first hand, and experience is gained that enables the young man to engage in business and put into practice the ideas he has gleaned in different parts of the world. In Austria there is a Government institution at Innsbruck, in connection with which there was established, a few years ago, a course of lectures and general instruction in hotel management, which has proved very successful. Instruction is given by competent professors under the direction of a board appointed by the Minister of the Interior. The course is known as the "Gästegewerblicher Fachkurs." Here, for a few weeks in the year, special information and technical knowledge relating to the hotel business are taught. The eastern part of Austria, like Switzerland, offers great attractions for tourists, and is visited each year by thousands. One of the secrets of their great success is the fact that hotel managers in these places in Austria have travelled widely, thus acquiring several languages, and have familiarized themselves with the tastes peculiar to each nationality. In Switzerland the Schweizer Hotel Verein has opened an hotel school under the name of the "Fachliche Fortbildungsschule des Schweizer Hotel Vereins," at Cou, near Lausanne, in a beautiful park overlooking Lake Geneva. Here the students receive careful attention as regards their physical, mental, and moral development. The institution is thoroughly organized and discipline is strict. The cost of board, lodging, and tuition is, for a native Swiss, £4 16s. per month; for a foreigner, £6 per month. Special reduced rates are quoted to native Swiss who are in straitened circumstances, but not more than four are admitted under these circumstances in any school year. According to the American Consular Assistant in Paris, the French hotel-keepers have conceived the plan of establishing a hotel school in Paris. One of the chief objects is to bring some system into the training of an hotel clerk. On account of the complex organisation of the modern hotel, with its electric and ice plants, laundries, hot-water supply, and various other departments, the manager with only a slight knowledge of book-keeping, hotel service, or the kitchen, is no longer able to fill his place adequately. A knowledge of hygiene, engineering, architecture, and especially languages, is essential. The Syndicat Général de l'Industrie Hôtelière et des Grands Hôtels de Paris, in January, 1910, organised a school, to be known as "l'École de l'Industrie Hôtelière," and an institution for lodging the students. The students will at all times be in constant touch with the director of the school, who will be a representative of the Syndicate. The number of boarding students for the first year has been limited to thirty. The minimum age of admission is sixteen. At the end of the school year, upon successfully passing the prescribed examination, certificates will be granted to all students meriting them, and the Syndicate thereupon will place the student for further instruction in one of the large hotels belonging to the union. The course of study during the first term is as follows:—Study of foreign languages, English and German; shorthand and typewriting, mathematics and book-keeping, geography and history, civil and commercial law. These branches are taught entirely from the standpoint of the hotel-keeper, and in consideration of the service to the guests. The course of study during the second term is as follows:—Political economy, hygiene, electricity, heating, insurance, laundries, menus, kitchens, etc. The afternoons will be devoted to visiting industrial establishments that supply hotels.

THE LIBERIAN SUGAR INDUSTRY.

In the early history of the Liberian Republic a large quantity of sugar was manufactured, and during the civil war large quantities of brown sugar were shipped to the United States. Along the banks of Liberian rivers are thousands of acres of land that could be profitably utilized for the culture of sugar-cane. In the case of forest land, the undergrowth is cut in January and the large trees felled about the beginning of February. After two or three weeks the dried vegetation is pulled up and the débris burned off. The land is dug up with hoes in rows about six feet apart. In three months after planting the cane attains a height of three or four feet. In nine or ten months the cane is ready for cutting, which is done with cutlasses, and the tops with three or four joints are preserved for replanting. According to the United States Chargé d'Affaires at Monrovia, cane-culture in Liberia is undeveloped. There is great need for capital to provide suitable machinery for preparing the soil, and for the introduction of modern methods of culture. The cane is ground in an ordinary three-roller mill, with a trough under it to catch the expressed juice which is carried to a reservoir, whence it is taken as required for cooking in large kettles. In

cooking, unslaked lime instead of cream of lime is used to produce granulation. When the juice attains a ropy thickness, a little is dropped into a bowl of water to determine if it has been sufficiently cooked. When it settles in the bottom of the bowl like candy it is ready for the next process, called in Liberia "striking," that is, it is removed from the kettles by means of long-handled dippers to a vat where it is stirred with a wooden ladle until it cools. It is then placed in wooden barrels with holes bored in the bottoms, sharpened sticks being run through the sugar to the holes to guide the dripping of the molasses. The barrels are placed on two poles over vats which catch the molasses as they drip. When the sugar is free of molasses it is dry and of a light golden colour. In this condition it is sold locally for about threepence a pound. Notwithstanding the large quantities of excellent cane grown in Liberia, and the much larger quantities that could be produced, almost the entire sugar consumption of the country is of imported beet sugar. This is largely due to the lack of capital to enable the sugar-planters of Liberia to compete with the beet-sugar producing countries.

PARAGUAYAN RUBBER.

In 1909 the first attempt was made to produce rubber in Paraguay. The experiment was tried by an industrial company owning extensive tracts of land which it exploits for the production of timber and yerba maté (Paraguay tea). On the lands of this company, in the northern part of the Republic, is a tree known in the local Guarany tongue as the "mangaicy" tree. In the Brazilian State of Matto Grosso, lying just north of Paraguay, the same tree is known as the "mangabeira." It is also called the "mangava." One authority states that all of these names refer to the rubber product of the tree, and that its true name is "curupicai," or "curupicahy." Possibly some assistance in identifying the tree may be gained from the following extract from a work on Paraguay by a German consul in that country:—"There are in Paraguay only a few species of gum woods growing in a wild state; among others should be mentioned the 'manga-ysy' and the 'ybyra camby.' Efforts are now being made to cultivate india-rubber trees, and a Brazilian species has been chosen called 'Manicoba' which grows more quickly and winters more easily." A description of the mangaicy tree upon which reliance could be placed for a proper classification has not been obtained. It grows in a distant part of the country, and accounts of it are as variable as the names applied to it. The mangaicy yields a milky sap known in Matto Grosso as "chiringa," which is collected by making a series of V-shaped incisions, one above another, in the bark of the tree. The lower points of the incisions are connected by cuttings, and a cup for catching the milk is fitted closely to the trunk of the tree beneath the lowest incision. After the milk is gathered it is coagulated by a solution of alum. The liquid matter is then drained off and the curd-like substance remaining is dried and subjected to a pressure which forms it into the rubber exported from Paraguay. In Matto Grosso the rubber product is known as "borracha." The trees are tapped from October to April, each tree yielding from eight to ten pounds of milk. A tree can be tapped every other year if conditions for growth are favourable, otherwise it should not be tapped more often than every three years. It is stated by some that a tree can be tapped in about three years after planting. According to others, they are not mature enough until six or seven years' old.

TRADE IN SOUTHERN PERSIA.

The condition of commercial affairs in Southern Persia during the year 1908-9 appears to have been very depressed, judging from the recent consular reports on Bushire, Bunder Abbas and Lingah. The most prominent feature in the case is the weakness and inability of the local governments of Shiraz and other chief towns to maintain order, and want of support accorded until quite recently by the policy of the British Government, within whose sphere of influence the region has been included under the Anglo-Russian Agreement. On the caravan route from Bushire to Shiraz, tribal fighting has been chronic, and on the road from Shiraz to Isfahan constant robberies and looting have continued to paralyse all commercial activity. The piece-goods trade suffered more especially, and Manchester lost at least £120,000 worth of business on the previous year's figures. Importing companies themselves have frequently had goods ordered out and thrown on their hands by bankrupt buyers, and the amount of outstanding claims presented for recovery from defaulting Persian traders during a period of eighteen months from the beginning of 1908 totalled more than £20,000.

The lack of transport on the great caravan route to Shiraz was also a factor which increased the difficulties of merchants. Extortion on the part of the armed tribesmen infesting the route to Shiraz, and frequent robberies, have made the lot of the muleteers hard; many indeed have left this route with their animals in order to find a more peaceable living on the northern caravan routes, where, it is presumed, Russian influence ensures greater security. The exactions, robberies, and diminished transport along the routes where British goods are so largely borne, have not only diminished the British trade, but have encouraged their place being taken by foreign merchandise imported from the north. Not only has British trade thus suffered very severely from the disorganized condition of government in the south, but unfortunately the prospects of an early return to the quietness necessary for the recovery of trade are not hopeful. The import figures of 1909-10 so far point to a more startling decline in imports than even those of the year under review.

At Bunder Abbas also trade has been bad, owing chiefly to the disturbed state of the country, which has rendered the trade routes most insecure. The total commerce of the port has declined by over £104,000 as compared with the previous year, a decrease of nearly 19 per cent. The imports from the United Kingdom have declined 5 per cent., and those from India 40 per cent., while the decreases in exports to those countries are similarly 35 and 13 per cent. The Consul adds that an increase of trade is not likely to occur until order has been generally restored in Persia, and that even then improved communications will be necessary to admit of any considerable expansion.

SOUTH AFRICAN PROGRESS.

According to the American Consul-General at Cape Town, one of the most striking indications of the healthy and prosperous condition of the country is the increase in railway receipts, and still more the demand for rolling-stock and equipment, which has necessitated the immediate placing of orders amounting to £700,000. Besides the branch lines now under construction in the Transvaal, Natal and Cape Colony, and other extensions in all these Colonies sanctioned by Parliament, the Cape to Cairo Railway probably will be completed by August, 1911, as far north as the Star of the Congo Mine, across the Belgian frontier, to tap the rich copper deposits in the Tanganyka district. In the Transvaal there are building contracts in hand to the extent of between £2,000,000 and £3,000,000 for the erection of the various government buildings for the Union Government at Pretoria, besides museums, schools and colleges at the other cities in the Transvaal. In addition to these, there is to be a new tramway line at Pretoria, costing about £80,000, and the installation of a complete sewerage system costing £100,000.

BRITISH COLUMBIAN HORTICULTURE.

The growth of the fruit industry of British Columbia may be estimated by returns of imported nursery stock which the provincial inspector of fruit pests has recently transmitted to the Government. The number of trees and plants inspected at Vancouver during the first four months of 1910 was 2,719,000. Every tree and plant is inspected as it passes through the station. This entails a vast amount of labour. Owing to this rigid inspection before the stock is delivered to the buyers for planting in Okanogan, Similkameen, East and West Kootenai, and the boundary country, there is not a trace of the San José scab or the brown tail or gipsy moth. The equal freedom from the codling moth corroborates the statement that the nursery stock received for planting purposes is subject to most rigid inspection, as well as fruit brought from eastern Canada, United States, and other countries. The importance of this fact to fruit-growers can hardly be overestimated, as it enables them to guarantee the soundness of fruit to purchasers. At the present rate of orchard planting, a large proportion of the arable land of the province will be used for this purpose. The fruit grown, according to the United States Consul-General at Vancouver, is of the same general character as to size, colour and flavour, as that grown in the famous orchards of the States of Washington and Oregon. During the year 1909 there were brought into the city of Vancouver 113,163 boxes of apples, pears, peaches, apricots, quinces and plums, which, with the amount received from the orchards situated in the province —about 35,000 boxes—shows a large consumption of fruit in Vancouver and the surrounding districts. Apples have been grown successfully at an altitude of 4,500 feet near Rossland, and from this district large shipments are expected, which will come into direct competition with those of the fruit grown in the States of California, Oregon and Washington.

THE GRAPE INDUSTRY OF ALMERIA.

The table grapes known commercially as Malaga grapes, are exported from Malaga in very small quantities. Almeria—the principal city of the province of the same name, situated about one hundred miles east of Malaga—is the centre of the grape-exporting industry of southern Spain. Originally the Almeria or Malaga grapes were cultivated only in, and about, a small town called Loja about fifty miles north of Malaga. Cuttings were distributed throughout the entire district, but Spain's finest table grapes, and the only grapes that will retain their freshness, firmness, and flavour for months after being cut from the vine, are the product of the old cuttings taken from Loja, and now cultivated in the province of Almeria. Owners of vineyards in the Malaga district have made repeated efforts to produce a grape possessing the keeping qualities of the Almeria fruit, without obtaining satisfactory results. Cuttings taken from Almeria produce a different grape when transplanted outside of that particular district. Cultivated in and about Malaga, the Almeria cuttings produce a tender, thin-skinned grape, more or less of the order of the muscatel. As no artificial means are adopted to aid in preservation, the splendid keeping qualities of the Almeria grape must be due to some peculiar properties contained in the soil of that district, combined with extremely favourable atmospheric and climatic conditions, as the fruit is thick-skinned and capable of resisting decay for seven or eight months when properly packed. There are a great many varieties of soils in which the grapes are grown—lime, clay, gravel and slate; but, according to the American Consul at Malaga, opinions differ as to which is most favourable for grape producing, some maintaining that the gravel and slate soils are best owing to the fact that they are more easily penetrated by the roots of the vine. The further they get down,

the better soil-nourishment the root receives. As regards temperature in the northern or higher districts, the average is 60° F. maximum, 52° minimum. In the southern or seaboard districts the average is about 110° maximum and 66° minimum. In Almeria the thermometer rarely falls below freezing-point. Thus it follows that the grapes in the latter districts are ripe about the beginning of August, while in the northern section the cutting is done from about the middle of September to the end of October. Heavy rain after the fruit has reached the ripening stage is prejudicial to the keeping quality of the fruit, especially if the grapes are cut too soon after a rain. Much rain in the months of April or May is dreaded by the grape farmers, as it is during these months that they apply the pollen from the black or "castiza" grape to the white export or "Ohanes" grape. This is probably the most anxious time for the producers, as their crop depends on the success of this operation. The greater part of the packing is done at the vineyards where the grapes are cut. Frequently, however, the grapes are cut, placed with care in esparto baskets, and carried on the backs of mules and donkeys to warehouses at the port, where the bunches are carefully inspected and all unsound and small fruit cut off, after which packing in barrels takes place. Grapes are often brought in this manner from villages as far as twenty miles inland. Some grapes already packed come from a distance of over sixty miles to the port, from the borders of the province. Cleaning and packing are done by women. The cleaners remove with scissors all berries that may be in any way damaged or stained, taking great care at the same time not to pierce the good berries. It is at this stage that classification takes place; the cleaner, on laying down each bunch, judges from its appearance, colour, size of berry, etc., to which class it must go. All grapes are packed in ground or granulated cork, the barrel being filled with a layer of cork and grapes alternately, while the packer shakes the barrel on completing each layer in order that all interstices may be filled up. The packers re-examine each bunch as they fill the barrels, snipping off with scissors any doubtful berries that may have escaped the eye of the cleaner. The importance of the grape trade of Almeria is shown by the last year's exports, amounting to 1,576,936 barrels, and production is said to be steadily increasing.

JAPANESE AND COREAN GINSENG.

It is a common belief in China that when all remedies have failed, and death is near, ginseng can restore the breath of life and ensure longevity. Many people in high stations in the East confirm these medicinal properties, hence the persistent demand for the root, concerning whose price fabulous sums are reported to have been paid. Its value, however, depends upon shape, texture, and manner of curing. To be valuable, the root must be so as to resemble somewhat the human form and semi-transparent, dry and flinty. As it is sold by weight, the size is also of importance, a good specimen sometimes bringing as much as £10, though inferior shapes and sizes bring very much lower prices. Ginseng roots of grotesque shape are more highly prized than the symmetrically-formed product. According to the Canadian Trade Commissioner in China, almost the whole ginseng trade of China is controlled by a group of Chinese merchants, whose headquarters are in Hong-Kong. They fix the prices, both wholesale and retail, and regulate from year to year the amount of ginseng imported into the country. In this way a practical monopoly of the trade is obtained. This is the reason why it is so difficult for foreign growers of ginseng to deal directly with Chinese merchants, and it is this feature of the trade that makes it more profitable, as a rule, to the small grower in other countries to sell his ginseng to some local commission house rather than to ship it to China himself. Japan is the great source of production of the ginseng consumed in China, and it is cultivated principally in Aizu, Shinano, and Izumo. It is a perennial plant, growing usually three to four years, when it is harvested. The yellowish-white root measures five to six inches long. The soil once cultivated with ginseng must not bear the same crop for fifteen to twenty years, otherwise it is liable to be attacked by plant diseases and pests, especially in an unfavourable season. The cultivation of ginseng in the Izumo district is carried on with greater attention and care than are bestowed upon it in other parts of Japan. Ginseng prefers a rather cold climate, and thrives well on a slope declined northward and thoroughly drained, and on clay or even sandy soil, provided the climatic conditions are favourable for its growth. In September the fourth-year plant is harvested, and the roots are carefully dug out, so as not to injure the rootlets, packed in bags and sold directly to the steeping factories or intermediate merchants. The harvested roots are washed clean and sorted into classes, according to their size. They are then put into lukewarm water in a kettle, and the temperature raised to nearly boiling-point, when the steeping or cooking will be finished. The steeped roots are then taken out of the kettle and spread out thinly. Any moisture on their surfaces is dried off as quickly as possible by fanning. If a properly-steeped root is cut through with a knife, the white translucent part in the middle of the root should be quite round and not irregular in shape. The roots are then transferred to an oven and dried by charcoal heat, from four to eight days according to the size of the roots. The oven consists of two boxes, upper and lower, the bottom of which is of thick pasted paper, and inserted into the oven. A charcoal fire is kept just under the two boxes, so that the drying temperature can be regulated in the oven itself after practical experience. In the beginning of the drying operation, only the lower box is

filled with the roots, the upper one being left empty, and the temperature of the lower box ranging about 150° F. At the expiration of ten hours, when the roots become soft and small wrinkles appear on their surface, the temperature is lowered to about 130° by covering the charcoal fire with straw ashes. After another ten hours, when the bulk of the roots becomes much smaller, the contents of each of the lower boxes are collected into one and transferred into the upper box, where the roots are gradually dried up ready for sale. The lower boxes thus emptied are filled with fresh roots, the same process as before being repeated. Nearly the whole quantity of ginseng produced in Japan is exported to China through the ports of Yokohama and Kobe. In Corea the ginseng industry has become a government monopoly. The industry is governed by strict regulations, and is carried on by farmers specially licensed, who cannot discontinue the business without special permission, and who must carry it on in districts specified by the government. The authorities inspect the product, and from it choose the finest roots for the making of red ginseng, paying a fixed and uniform rate therefor. The famous red ginseng, which is such a favourite in China, is made by steam-baking the yellow or white ginseng. This red ginseng is cured only at Songdo, its manufacture and export being a government monopoly.

EMPIRE NOTES.

The Parliament of United South Africa.—The opening of the first Parliament of United South Africa by H.R.H. The Duke of Connaught, was important, not only from the point of view of the results which are likely to follow in that country from the establishment of a responsible Government—the sphere of whose duties will cover the whole of that great Dominion—but from the influence of this step on the Empire itself. The fact that Australia, New Zealand and Canada sent distinguished representatives to meet the Royal Duke and to express the good wishes of the countries they represented on the consummation of the great movement which has been so fittingly marked by the proceedings at the opening of the new Parliament, is indicative of the spirit of union between the various parts of the Empire. How far the principle of federation which has been adopted in South Africa is an improvement on the Commonwealth principle of Australia, is a question which can only be determined by a consideration of local conditions. At the same time, it is interesting to note that the Federal Government of Australia appears to be moving more and more in the direction of federation, and of limiting, as far as possible, the powers of the separate States' Parliaments.

The South African Industrial Commission.—At a Commercial Congress, held in Bloemfontein in July last, the Hon. F. R. Moor, the present Minister of Commerce and Industry for the Union of South Africa, expressed his willingness to promote, as far as possible, a Commission of Inquiry into the agricultural, commercial and industrial conditions and needs of South Africa. The proposed inquiry will cover a wide field, including the conditions of existing industries, the cost and class of labour employed, the production of raw materials, the effect of the present tariff and railway rates, the prospect of developing fresh industries, and the increased use of white labour. The question also of facilitating the export trade of the country will be considered, and the improvement of transport arrangements, both by land and sea. The Commission will consist of two members each from Cape Colony and the Transvaal, and one each from the Orange River Colony and Natal.

Westralia's New Gold Mine.—There seems to be every prospect, from the recent mining developments in the neighbourhood of Southern Cross in Western Australia, that a new Kalgoorlie has been discovered. The Bullfinch Mine, 22½ miles from Southern Cross—the first of the series of mines being opened on the line of reef running to the north-west of that old mining centre—is yielding remarkable results. These, however, are not of the "patchy" character of some of the early gold finds of Western Australia, which occasioned so much excitement when discovered, and became so disappointing afterwards; the nature of the ore bodies indicates permanence. The outcrop of the mine, the examination of which led to the discovery of the auriferous character of the district, is a dense ironstone, similar, it is said, to thousands seen all over the country, and to all appearance equally barren. This outcrop, which was only a foot or two in height, was scarcely noticeable from a short distance. No visible gold appeared in it, but, when samples were assayed, they were found to contain seven ounces of gold to the ton. This assay was confirmed by bulk samples as the mine was opened. The lode appears to strike north-west and south-east, and has a very steep underlay to the south, which, like the Boulder lodes, is practically vertical. It consists of schists, ironstone and quartz, and the vertical shaft on the west shows it is in greenstone, which, according to geologists, and also to the experience of the Boulder, Gwalia and Great Fingall Mines, is the best indication of permanence in Western Australia. Other mines have been opened on the line of the Bullfinch reef, some of which consist of immense ore bodies carrying payable gold. An area of 10,000 acres has been leased to various mining parties in the vicinity already. Recently, some members of the Ministry, accompanied by the Government geologist, visited the district, and their report fully confirms the magnitude and importance of the discovery, which will have far-reaching effects on the State, and will materially assist the movement towards

immigration that has been so vigorously taken up by the Government during the last few months.

The Northern Territory of Australia.—After many months of debate, the Northern Territory Acceptance Bill has now passed through all its stages in both Federal Houses of Parliament, and the Commonwealth becomes possessed of a large tract of country. By agreement with the South Australian Parliament, the Federal Government assumes certain obligations relative to railways and development, and takes over a debt of about £3,000,000, accumulated on behalf of the Territory. Although for some time to come it will prove a source of loss to the Commonwealth, it is anticipated that in a few years it will become a flourishing state and provide homes for many hundreds of thousands of settlers. For purposes of defence it has become a matter of necessity that it should be annexed by the Commonwealth, and for that reason no time should be lost in settling a large number of people upon it. The population of this immense area, comprising as it does 523,620 square miles, according to the latest return, is only 3,004, of which number 1,081 are Europeans, and the remainder Asiatics. There is no possibility of stating the number of aboriginals, but they are numerous on the coast-line. The territory is rich in mineral wealth, and during the year 1909 gold bullion amounting to 7,164 ozs. and valued at £23,526 was exported. Tin ore and concentrates to the extent of 454 tons, valued at £37,496 were also exported. A small quantity of copper, 118 tons, was raised, and 73 tons left the country. The export of wolfram amounted to 44 tons, valued at £4,294. Recent exploration has shown that there is some magnificent country in the northern and central portions, admirably suited for raising sheep, horses and cattle, and when the south to north transcontinental railway is constructed this belt of country will be of immense value.

An All-British Cable.—The trans-Atlantic cable systems represent the one missing link in an all-British cable communication, and the case to be brought forward shortly for an "all-red" cable route is a strong one, alike with regard to political, social and commercial imperial interest. There are at present sixteen cables across the Atlantic, controlled by four different companies, and now the United States' grip of the entire system threatens to create a situation which cannot be contemplated without serious uneasiness, as the control of these companies is gradually passing into the hands of a great American trust. With the United States monopoly the demand for a cable controlled by the British Government will have behind it a practical force hither unappreciated by those who have treated the scheme as a mere vision of the empire builder.

Canadian Markets for New Zealand Meat.—There is evidently an excellent opening for the New Zealand frozen lamb and mutton trade in Canada, according to a statement by Mr. W. A. Beddoe in the course of an address before the Auckland (New Zealand) Chamber of Commerce recently. He said that it had occurred to him that the frozen mutton trade which might be developed with Canada was somewhat neglected. As Canada had very few sheep—there were only 3,000,000 to a population of 8,000,000 people—there ought to be a good market there for New Zealand mutton. In Vancouver they would be only too glad to get New Zealand frozen mutton, and in Montreal there were no fewer than 600,000 mutton-eating people. There was a trade there in embryo. They recognised in Canada that if they were to do a big trade they must buy as well as sell. Although Canada was a great butter and cheese-producing country, this only applied to the east. Western Canada was not supplied as it might be, for the simple reason that the distance from Halifax to Vancouver was greater than from Halifax to Liverpool. He thought that in Western Canada, a fruit-growing and mineral-producing country, there was a big market for New Zealand dairy produce, and that at Montreal there was a big market for New Zealand frozen meat.

A Valuable Indian Sugar by-Product.—In India, bagasse—the refuse from the sugar cane—has up to the present, only been used for fuel. This is evidently an unnecessary waste, as in the West Indies this refuse is turned into paper-pulp and is used by local paper manufacturers and also exported, realising from £5 to £15 per ton, according to quality. In Cuba, too, practical tests are being made in this direction, and were described in the *Journal* of the 4th inst. It appears, moreover, that the quality of the pulp can be greatly improved by the addition of fibrous materials, such as bamboo and grasses, banana stalks and leaves, of which there is a plentiful supply in India. As it is estimated that there is a ton of refuse to each ton of sugar produced, and as the sugar of India yielded over two million tons last year, at the lowest computation, the bagasse should bring in ten million pounds sterling per annum. Nowadays, manufacturers realise that in many trades the profits can only be culled from by-products.

GENERAL NOTES.

THE SWISS DAIRYING INDUSTRY.—Dairy farming constitutes an important industry in Switzerland. The production and treatment of large quantities of milk, consumed in numerous chocolate factories and milk-condensing concerns in the Confederation, the domestic consumption of milk, butter and cheese, and the preparation of cheese for export, engage the attention and services of a large number of people. There are 2,100 dairies in Switzerland, which employ on an average four persons each, making a total of 8,400 people

engaged in the business. Of these about 1,400 are devoted to the production of Ementhal cheese, a brand which constitutes the principal part of the cheese exports. This calculation does not include a considerable number of people who are engaged in what are called "Alps," a term applied to the little valleys in the higher mountain altitudes, where peasants take their cows in summer, and where in small huts and stables the attendants and animals remain for several months in the year. The cows thrive on the sweet tender grasses that grow in these high altitudes, and there, by crude methods, the herdsmen convert the milk into cheese and butter. Many of the men who attend the animals in the Alps do not leave these mountain retreats during the entire season, enduring a life of isolation and toil, which is, however, spent in the midst of the most magnificent scenery. The value of Swiss cheese exports for 1909 was £2,433,000, and the price was higher than in 1908. Notwithstanding the increase in the volume of the exports and the advance in price, the Swiss manufacturers complain of small profits on the year's business, claiming that it is because of the superior quality only of their products that they are able to compete in the foreign markets.

GLASS AND PORCELAIN BRICKS.—The demand for glass and porcelain bricks is very keen in Germany, and many factories in that country are now producing them. Three types of glass bricks are well known. One, the Falconnier hollow brick, of singular and irregular shape; another, a hollow, rectangular brick, similar in shape to a common brick; and finally, a pressed glass brick made in the form of a thick letter U. Glass bricks, when carefully handled, seldom crack or break, but they are very sensitive to changes of temperature. Porcelain bricks are exceedingly uncommon, although there are a few houses in Hamburg the exterior walls of which are faced with them. These bricks were made near Stettin, from clay found on the island of Bornholm, in the Baltic. It seems unlikely that they will ever become popular, as they are very heavy and expensive, and in the case of glass bricks the chief obstacle to their more extensive use is their inability to support more than their own weight, or even this when the wall exceeds fifteen feet in height. Consequently girders must be provided, or ordinary window openings made in such a manner that the walls of glass sustain no pressure. The bricks are delivered to contractors loosely packed in straw. The mortar used in laying them is composed of one part of fine sand to four parts of cement. The hollow, rectangular glass bricks have become of late the most popular form among German builders. They are thicker than the Falconnier bricks, and are more valuable for fire-proofing purposes. Glass bricks can never be more than special-purpose building materials, particularly useful where walls instead of windows are essential, while at the same time light must be provided.

THE BOTANICAL JOURNAL.—The *Quarterly Record* of the Royal Botanic Society has been discontinued, and its place is taken by the *Botanical Journal*, a monthly periodical. The first (October) number contains an editorial article on the work of the Society, reports of the proceedings, general articles and notes, and is illustrated with three excellent coloured plates.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOVEMBER 21...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. C. R. Darling, "Industrial Pyrometry." (Lecture I.)

Bibliographical, 20, Hanover-square, W., 5 p.m. Sir Herbert George Fordham, "Descriptive Catalogues of Maps: their Arrangement, and the Details they should Contain," with an Exhibition of Specimens.

Geographical, Burlington-gardens, W., 8.30 p.m. Dr. Filippo De Filippi, "Some Results of the Duke of the Abruzzi's Karakoram Expedition."

Junior Engineers, Caxton Hall, Westminster, S.W. Mr. L. W. J. Costello, "The Law Relating to Engineering." (Lecture IV.)

London Institution, Finsbury-circus, E.C., 5 p.m. Rev. T. T. Norgate, "Corsica, the Land of the Vendetta."

TUESDAY, NOVEMBER 22...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. H. K. G. Bamber, "Portland Cement, and the Question of its Aeration."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. S. E. Fincham, "The Dauphiné District of Southern France, with Notes on the Palace of Versailles."

Horticultural, Vincent-square, Westminster, S.W., 3 p.m. Mr. J. Hudson, "Plants in Congenial Positions."

WEDNESDAY, NOVEMBER 23...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Sir Henry Hardinge Cunynghame, "Methods of Detecting Fire-Damp in Mines."

Geological, Burlington House, W., 8 p.m.

Royal Society of Literature, 20, Hanover-square, W., 5 p.m. Rev. J. Arbuthnot Nairn, "Illustrations from Papyri of the Manners and Customs of Ancient Egypt."

British Astronomical, Sion College, Victoria Embankment, E.C., 5 p.m.

THURSDAY, NOVEMBER 24...Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

London Institution, Finsbury Circus, E.C., 6 p.m. Mr. E. Markham Lee, "Chopin—the Man and his Music."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. C. Phillips, "X Rays in Theory and Practice."

Electrical Engineers, Victoria Embankment, W.C., 8 p.m. Mr. H. T. Harrison, "Street Lighting by Modern Electric Lamps."

FRIDAY, NOVEMBER 25...North-East Coast Inst. of Engineers and Shipbuilders, Newcastle-on-Tyne, 7.30 p.m.

Physical, Imperial College of Science, South Kensington, S.W., 5 p.m. 1. Dr. A. Russell, "The Electric Stress at which ionisation begins in air." 2. Dr. A. Griffiths, "On the measurement of a flow of water in a closed circuit by a method involving little or no statical friction." 3. Mr. J. S. Dow, "Exhibition of a surface brightness photometer." 4. Mr. L. F. Richardson, "The approximate solution of various boundary problems by surface integration combined with freehand graphs."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, NOVEMBER 28th, 8 p.m. (Cantor Lecture.) CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "Industrial Pyrometry." (Lecture II.)

TUESDAY, NOVEMBER 29th, 4.30 p.m. (Colonial Section.) A. MONTGOMERY, M.A., F.G.S., State Mining Engineer to the Government of Western Australia, "The Progress and Prospects of Mining in Western Australia." Admiral Sir FREDERICK GEORGE DENHAN BEDFORD, G.C.B., late Governor of Western Australia, will preside.

WEDNESDAY, NOVEMBER 30th, 8 p.m. (Ordinary Meeting.) CAMPBELL P. OGILVIE, "Argentina from a British Point of View." Sir ALEXANDER HENDERSON, Bart., will preside. (The paper will be illustrated with lantern slides and cinematograph views.)

Further particulars of the Society's meetings will be found at the end of this number.

"INDUSTRIAL ENGLAND IN 1754."

In accordance with a resolution passed by the Council* the Paper read before the Society on April 20th, 1910, by the Secretary, has now been published in book form, with corrections and additions, under the title "Industrial England in the Middle of the Eighteenth Century." The price of the book is 5*s.* net, and copies may be obtained of the publisher, Mr. John Murray, Albemarle-street, London, W.

PROCEEDINGS OF THE SOCIETY.

SECOND ORDINARY MEETING.

Wednesday, November 23rd, 1910; the Hon. RICHARD CLERE PARSONS, M.A., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Barrington, Mrs. Russell, 4, Melbury-road, Kensington, W.

Bruce-Williams, M., Green Hurst, Beaconsfield, Bucks.

Hepburn, Edward, Monkridge, Sidcup, Kent.

Jacobson, Richard, 70, Shoe-lane, E.C.

Laing, Miss Theresa T., Etal-manor, Cornhill-on-Tweed, R.S.O., N.B.

Wentworth-Sheilds, Francis Ernest, M.Inst.C.E., Docks Engineer's Office, Southampton.

Wolfenden, Stuart J. Norris, Conservative Club, St. James's-street, S.W.

The paper read was—

METHODS OF DETECTING FIRE-DAMP IN MINES.

By SIR HENRY H. CUNYNGHAME, K.C.B.

The object of my Paper is to give a brief description of the principal methods of detecting fire-damp in mines.

You are no doubt aware that in early mining fire-damp, or fire-vapour, constituted a very dreaded danger, and that the invention of Sir Humphry Davy first afforded a means of carrying a light with safety into a fiery atmosphere. The principle of this lamp, as you know, is that copper-wire gauze acts as a sieve or filter to ignited gas, the heat being abstracted by the gauze and remaining in it, and thus the flame is extinguished.

For many years explosions in mines were put down to fire-damp. Gradually, however, the idea started by Faraday gained ground, that though an ignition of fire-damp might originate an explosion, yet the explosion itself was due to coal-dust. And after the Tylorstown disaster it was shown that the majority of men killed in these explosions do not perish from fire, but die from the effects of the poisonous after-damp. So that we now know that when there is a big explosion—as at Whitehaven—it is not an explosion of fire-damp killing men by its violence, but an explosion of coal-dust which destroys its victims by poison. Ninety per cent. of the men die in this manner: fortunately the death is a painless one.

* See Report of the Council, *Journal*, vol. lviii., p. 753.

Although fire-damp does not play the part in mine explosions which was once supposed, yet it is still very important to keep it under. Small local explosions of fire-damp are the only ones which now occur—for it would be impossible for a mine to get filled from end to end with fire-damp without discovery—yet these small local explosions injure and kill working parties, and they may originate formidable explosions by setting on fire the impalpable coal-dust that is always floating about. Hence it is absolutely necessary to keep mines clear of fire-damp. Most of the ventilating air sent into a colliery is directed to this aim, for though, of course, it is necessary that men should have pure air to work in, it is far more necessary still that the fire-damp should be cleared away and carried up the up-cast shaft, which is always more or less impregnated with fire-damp.

Fire-damp—or to use its chemical name, methane — is a compound of carbon and hydrogen. It is formed wherever vegetable fibre is decaying under water. It is given off from coal, which is only a fossil vegetable. It is also given off from marshy ponds, and bubbles of it arising from them can be set on fire.

In mines such as the hematite mines, where vast quantities of pit-wood are accumulated, often soaked in water, fire-damp has been found, although there is no trace of coal in the vicinity. Even small explosions have occurred in such mines.

But the chief source of fire-damp is coal. When coal is heated in a retort gases are driven off which consist principally of methane, and are used for burning in ordinary life. Coal-gas and methane are, therefore, very similar in composition and in behaviour.

The amount of methane which, if present in air, will make it explosive varies from about 6½ to 18 per cent. With less than 6½ per cent. there is not enough methane to carry on the combustion. With more than 18 per cent. of methane there is not enough oxygen to carry on the combustion. The most explosive mixture is about half-way between these extremes—namely, about 10 per cent. In this case, theoretically, the whole of the methane and all the oxygen in the air ought to be united, causing as products steam and carbonic acid, with traces also of carbon monoxide. And the volume of the resultant gases ought, when cool, to be diminished by double the proportion of the methane originally present. Thus, if 5 per cent. of methane is added to a given volume of air, then, when the methane is burned up with some of the oxygen of that air and cooled again, the resulting volume will be 10 per cent. less than it was before.

The dangers of methane render it very desirable that a means should be found of detecting its presence. This, of course, can only be done by taking advantage of some physical properties by which methane differs from air so as to afford a guide to its recognition.

We can detect coal-gas by reason of the smell, due to some volatile constituents which are released by the heat of the gas-retorts. But pure methane has no smell, and this method —which would, if it were practicable, be the simplest—is not practicable. Methane, if heated, has no effect, or practically no effect, on man. One can, therefore, breathe perfectly in an explosive atmosphere and be quite unaware of its danger. But methane is much lighter than air. Here, then, we have a possible means of detection. For instance, a very light balloon, filled with air heavily contaminated with methane, would rise in ordinary air, but so feebly that this method is not applicable to the detection of the small quantities which, as we have seen above, are explosive.

There is, however, a method of making use of the lightness of methane which is both ingenious and to some extent practicable.

In order to explain it I must say a few words on the nature of gases. I address them, of course, not to scientific chemists, but to that portion of my audience whose life has been passed in a contest rather with practical questions than with theoretic ones.

The old notion of a gas was that of an elastic mobile body, something like a sponge which could be squeezed into a smaller space, but which, if released, would expand somewhat as does a hair pillow. But, unlike a sponge, the gas would, if free, expand indefinitely, so that this old elastic theory of gases, which accorded very well with observed tables of volumes and pressures, presented in theory considerable difficulty, for if a gas could expand indefinitely and yet were a uniform homogeneous body, how could we imagine a cubic inch of gas when liberated filling the universe? The idea seemed absurd of a body which, without addition to its mass, could swell up absolutely without any limit at all, so as to fill an infinite space.

Besides, it was observed that gases had an extraordinary power of packing themselves into one another, so that two gases expanding against one another, if allowed to mix, did not behave like two spring mattresses, but stored them-

selves into one another as if there were an interpenetration of the parts without addition of volume. Besides this, when gases were reduced to a condition of high rarification and electrified, they behaved in an extraordinary manner, which made them rather resemble swarms of meteors than elastic cushions.

These considerations arose at a time when new light was being thrown on the nature of matter. Instead of considering matter as solid stuff capable of being indefinitely divided, chemical science rendered it necessary to consider matter as composed of atoms and molecules, so as to be like, say, the hard roe of a herring. Of course, each little atom on this view could not be considered like a marble. For then you would ask, Of what is the marble composed? It was necessary, therefore, to treat the atom as an impalpable small field of force, of the nature of which we are quite ignorant: it might be a whirl in an ether, but was not severable into other similar whirls; it possessed a volume, a size, and a weight of its own, but was not resolvable into two atoms because it was rather of the nature of a centre of force exerting its influences at small fixed distances which gave it the power of occupying space and yet without the capability of being divided.

Once the existence of these atoms was admitted it became easy to consider solids as made up of a quantity of them bound together, liquids to be a quantity of them in contact but capable of sliding like marbles in a bag, and then the step became easy to consider a gas as a quantity of such atoms which had by means of motion—or, in other words, heat—being communicated to them acquired the power of flying and were always engaged in shooting about in all directions, ricocheting against one another, and against the walls of the chamber in which they were confined, just like a quantity of excited flies contained in a bottle.

In this way the expansibility of gas could be explained. The pressure exerted by gases against the sides of their containers was accounted for. The fact that gases when heated—*i.e.*, when motion is poured into them—exert greater pressure and try to expand, was explained by the greater velocity of the flight of the molecules, and, in fact, the laws affecting gases—the laws of Boyle, of Marriotte, and others—all found a ready explanation, and it was possible to compute the number of molecules in a certain volume, their velocity, and the average distance each could fly without hitting up against another molecule.

On this theory we must compare air to a number of heavy flies, and methane to a swarm of light, quicker-flying mosquitoes. Now, suppose we bring two chambers, one containing air molecules and the other containing methane molecules, into contact and remove the partition between them. At once they will begin to diffuse into one another. The flies will invade the realm of the mosquitoes, the mosquitoes will invade the realm of the flies. And which will do it quickest? Clearly those who can fly the quickest. So that it is certain that a mosquito or two will have got right through the realm of the flies and hit the outer boundary quicker than the first fly will have penetrated the mosquitoes.

How fast this will take place depends on the numbers of flies and mosquitoes that there are, and how closely they are packed, as well as how rapidly they fly. If we want to measure this rapidity we must somehow impede their motions, for they mix so quickly when free that observation cannot follow them. Hence, then, instead of letting the swarms come into contact we put a grating between them, through which they can only get slowly, and by this means we can render the measurement of their progress possible.

In practice this is done by putting the two gases into separate chambers divided by a porous diaphragm of plaster of Paris which, though to our grosser senses it appears a solid, is not a solid but a sieve containing numberless passages through which enterprising mosquitoes and flies will find their way, urged in their progress by their own initial velocities and the kicks of their comrades behind. The temperature of the gases will, of course, remain uniform, or, if it in any way suffered by the passage of the molecules through the diaphragm, it would be restored by communication of heat from the air around. Hence the motion of the molecules which is the cause of the heat will remain unchanged.

After a short time, therefore, it will be found that in each compartment there are both mosquitoes and flies, but that the proportion of mosquitoes that have passed into the fly compartment is greater than the proportion of flies that have gone the other way. Whence one compartment must be more full than the other, and since in both the velocity of the flies and mosquitoes is the same, the pressure must be greater in that compartment, owing to the increased battery of the inmates against the sides. Hence, if each compartment be fitted with a barometer, we should find the reading on the side which contained methane lower than

the other. By this means the presence of methane might be established.

This method, however, is attended with disadvantages. Fresh uncontaminated air must be brought in the instrument from the surface, and when one experiment is completed this air must be renewed. Again, impurities other than methane may obscure the results. Thus, if carbonic acid is present, it will produce an effect the reverse of methane, and consequently a mixture of air, methane and carbonic acid may be taken for pure air.

An invention has been made by which a small thin column of mercury is substituted for the barometer.

The next method is to use the pitch of an organ pipe. Of course, in contaminated air an organ pipe of a particular pitch will sound a different note from that which it gives in pure air. Accordingly the difference of note may be observed and conclusions drawn.

We now pass to electrical methods, dependent on the effect of burning methane in contact with a red-hot wire. The proposal of this is due to Mr. Liveing, son of the well-known chemist. If two platinum wires of equal length and size are both heated by the same current, and to the same degree, that one which is in air will exhibit much less of a glow than that which is in the mixture of air and methane. The difference can be estimated by the eye and the methane judged. An improvement on this instrument has been made by Mr. Arnold Philip for the Admiralty, or rather a modification. This consists in measuring the increased resistance of a heated platinum wire when immersed in an atmosphere containing methane. I am not in a position to say how this works. The criticism I should make upon it is that the platinum wire may become filled with occluded air, and hence vary in the degree of its resistance; but I think this might probably be overcome.

The next instrument depends upon the refraction under air and methane. The velocity of light in the different media will be different, and therefore by the proper arrangement of rays of light defraction bands may be introduced as shown in the diagram before you.

The above methods have been briefly reviewed in order to make it clear that they afford a possible basis for future machines. None of them have been very successful hitherto, and hence in practical use it has been necessary to fall back on one of the oldest methods, namely, the behaviour of flame when subjected to the influence of methane in the atmosphere in which it is burned.

A candle or lamp flame consists of burning gas which is distilled from melted wax or from oil sucked up into the wick. The flame consists of two parts, the body and the mantle. The body is usually yellow, the mantle is a very pale ghost-like colour. When the flame is brought into air containing any combustible gas or vapour, such as methane, a cap appears over the mantle. This cap is usually very pale, so pale that it can be distinguished only with difficulty. Its exterior edge is near the mantle, and owing to the brightness of the body it is generally impossible to see, unless the lamp is turned down so as to make the whole flame as small as possible. Thus, by turning the light very low, it is possible to see a cap when there is 1½ or 2 per cent. of methane in the air, and to see it clearly when the amount rises to 3 or 4 or 5 per cent.

The more volatile the oil, the better the flame is seen. Thus naphtha or benzine spirit shows the cap better than colza. And, again, the more pale and colourless the flame the better can the cap be recognised, hence flames of alcohol or gas are very suitable. With the Clowes lamp 1 per cent. of methane can be detected.

The character and height of the cap are indicative of the amount of gas present. With 1½ per cent. the cap forms a truncated cone, with 2 per cent. it forms a pointed triangle, which becomes more acute as the percentage rises.

In order to facilitate the detection of firedamp, the Home Department has issued cards containing coloured drawings of flames showing the caps upon them.

It only remains for me to describe and show an improvement introduced into safety lamps by myself and Professor Cadman of Birmingham, whereby the cap on flames is rendered more visible.

Everyone knows the effect produced by introducing into a Bunsen gas flame, or into an alcohol flame, a wire dipped in a salt of sodium. The invisible flame is at once turned to a bright yellow colour and becomes visible.

The familiar snapdragon is an instance of a similar phenomenon.

Exactly the same thing can be done with a miner's lamp. By mounting a small piece of asbestos steeped in carbonate of soda so as to be capable of being introduced into the flame of a miner's lamp, a gas cap is rendered easy to see.

In addition, there is the great advantage that it is not necessary to turn the light down, and so no danger that the light will go out.

It lastly remains only to describe the most accurate method of detecting gas in mines, but one which takes a little time, and is not suited for use by miners. I mean the method of gas analysis.

The plan is to take a measured quantity of the suspected air, and to pass it into a chamber in which is a red-hot platinum wire. The methane is thus burned out of it. The air is then sent back into the original chamber, free of methane, but containing carbonic acid, and its volume is again measured.

The apparatus on the table is the design of Dr. Haldane, and is being generally employed.

The value of this method is, of course, very great for checking results otherwise obtained.

These are the means at present in practical use for the detection and estimation of fire-damp. They are not yet perfect, but they are daily being improved, and with a very moderate degree of training ought to render the measurement of methane a simple and rapid matter.

[The paper was illustrated by numerous experiments which had been prepared by Professor John Cadman of Birmingham University.]

DISCUSSION.

The CHAIRMAN, in opening the discussion, thought all present would agree that the experiments they had seen were of a most interesting nature, because the subject of Fire-Damp and Explosions in Mines was of such very great importance that any improvement that could be made in detecting fire-damp and explosive gases so as to prevent explosions occurring must be of benefit to the community. He had been very much struck with the author's remark that all the beautiful methods that had been invented for detecting gases were satisfactory only up to a certain point, because it was of great importance not to induce a miner to rely too much upon a method of detecting explosive gases, as he might thereby become foolhardy and might think there was no gas in a mine, when all the time there might be a sufficient percentage present to produce an explosion. The author was, he thought, very much to be congratulated upon the interest he took in the question, because, occupying the important position he did at the Home Office, it was of enormous benefit to the general public to have such a scientific man taking so much interest in such an important subject.

Dr. J. S. HALDANE, F.R.S., said he had watched the beautiful experiments which the author had made with the very greatest pleasure, because they were entirely new to him. The simile of flies in a bottle was an extraordinarily vivid and apt one, because it exactly conveyed to the ordinary mind what physicists and chemists believed was happening with the molecules of gas, and the same remark applied to the simile of bluebottles for the carbonic acid, and mosquitoes for the fire-damp. He thought those comparisons would become classical, and that they would frequently be heard in the future in other lectures. It seemed to him that the new method of testing with sodium, devised by the author and Professor Cadman, made it practicable to carry out testing for a gas in ordinary mines in a far more thorough way than had been the case before. He knew well what it was to have the fear of losing one's light in a mine. He was ashamed to say he often lost his light, and, were it not for the fact that somebody was with him who had a light, he would have been left in darkness. The method described, however, made it possible for the official inspecting a mine to examine at any moment for gas with comfort and great celerity. It was an extraordinary improvement on the old method of testing, and left no excuse for not examining the airways of a mine thoroughly.

Mr. T. RATCLIFFE ELLIS said that in the popular view accidents in mines were generally attributed to explosions of gas. Of course there were many other causes, but that was considered to be the one against which special precautions required to be taken. That it was extremely dangerous, he thought, few people would deny. Every attempt was made in mines to lessen that danger by having ventilation which was sufficient to clear off the gases. An examination was made by officials before the men went to work, once or twice during the time they were at work, and it was also the duty of the workman himself to examine his working place to see if it was free from gas. Upon the care with which that examination was made must very largely depend the safety of the men employed in the mine; and any advance which could be made in the direction of producing a lamp which would more readily find gas, and was not subject to the disadvantages which had been pointed out of the lamp being extinguished, would go a long way in the direction of saving life and lessening dangers in mines. As the author had pointed out, the flame must be lowered in order that the gas might be seen, and although two per cent. or two and a half per cent. might not in itself be dangerous, it indicated a state of things which required careful watching. He thought it might be the case that the fear of losing the light did sometimes interfere with that carefulness in the examination for gas which was necessary. He was not competent to pass any opinion upon the general merits of the lamp, but inasmuch as it enabled a much smaller quantity of gas to be distinguished without the chance of losing the light, it seemed to him it was a very great advance on the present safety lamp.

Professor JOHN CADMAN said the author had referred to the work which it was his (Professor Cadman's) privilege to do in conjunction with him in connection with the investigation of the flames of safety lamps, and had mentioned the lamp-chamber which had been constructed in Birmingham University for the purpose of making an examination which was as realistic as possible. The author and himself were enclosed in that chamber, and fire-damp, which had been previously generated, was passed into the chamber in measured quantities in order to get various percentages. His own portion of the work was to provide mixtures in which both the author and himself sat, and to analyse them periodically to see that the proper standard of mixture was being obtained. At the same time, the author painted the beautiful pictures which he believed many of those present had already seen. When the idea of the sodium occurred to the author, the top was taken off the lamp, after a very careful test, and after he had assured Sir Henry that the Mines Regulation Act did not apply to the place in which they were sitting! An interesting feature was that they were locked in the chamber, there being nothing but a small pipe-hole leading from the outside, and they suddenly discovered they had no sodium. The passing of a bottle of sodium through the door would have meant that the mixture would be altered; but Sir Henry, who was, he believed, at the time a martyr to indigestion, produced some tablets of sodium carbonate from his pocket, and by taking one of the lamps to pieces and getting some asbestos from it they were able to produce a sodium flame. Then it was suddenly found that the oxygen was getting rather low, as both the author and himself began to pant slightly, and they also knew that as the lights would be going out in a few moments the whole experiment would be at an end. The author immediately suggested that some oxygen might be introduced, and he (Professor Cadman) therefore telephoned through the wall for the assistant to blow some oxygen into the chamber. That was immediately done, so that the air in the chamber was made breathable again and it was possible to continue the experiment. He mentioned those facts to show the enthusiasm with which the author entered into that kind of work, and he thought the mining public did not sufficiently realise the very valuable work which Sir Henry did on its behalf. It had been a very great pleasure to him to assist the author in any way in providing the apparatus to illustrate such an interesting lecture.

Mr. LEON GASTER said that he was present at the recent Congress of Hygiene at Brussels, which was attended by many factory inspectors, doctors, and legislators, and he had been particularly struck by the admiration expressed on all sides for the enthusiasm with which English scientists were carrying out investigations into such subjects as fire-damp and lead-poisoning; while Dr. Haldane's method of testing in caisson work had been accepted as the best in existence. The author had mentioned a very important point when he suggested that the sight of all the miners ought to be examined. He would like to see it part of the law that all those who had to be relied upon in connection with mining work should have their eyesight tested for the purpose of ascertaining whether they could detect the cap on the flame denoting the presence of gas.

Mr. W. C. BLACKETT desired to say a few words from the practical side compared with the scientific side dealt with by the author, as for thirty years he had made his living in mines, and had studied them from all points of view. Coming, as he did, from the north of England, he would like to say that no body of coal-owners and managers more recognised the efforts of the author than those in that part of the country. It was the scientific point of view that methane had no smell, but the gas usually given off in mines which was scientifically called methane had a faint smell. He did not say that that smell was of any great value, because it was only when it was pretty strong that one could be sure of detecting it; but all men who had studied the subject down the mine would unite in saying that methane, as found in the mine, had a certain smell which was observable by certain noses. With regard to the practical value of the appliances which had been shown, he was inclined to be a little sceptical. By the time the appliance gave the alarm to the manager, or the over-man, the real danger had taken place in a remote part of the mine; it was as likely to be in a working place as anywhere else, and therefore they were again thrown back on the safety lamp of the miner. The real guard against the danger of gas in a mine was the ordinary safety lamp of the miner, and so far as he could see at present, it was likely to remain so until some entirely different form of light was adopted. Coming to the question of caps, he had heard the statement made by one individual that half an inch of cap betokened great danger, because it indicated a certain definite percentage of fire-damp; while within a very short time he had heard another individual say that half an inch of cap betokened no danger at all. The truth was that half an inch of cap did not mean a definite percentage of gas, inasmuch as if the flame of the safety lamp was reduced to the smallest speck of blue for testing the gas, a less cap was obtained than if the smallest speck of yellow light, such as the author used, was present, the one representing four per cent. and the other under three per cent. The loose way of speaking of the cap was responsible for that difference. Dealing with the question of the eyesight of miners, unfortunately his own sight had been put to very severe trial, and he

could not see as well at present as he could years ago, but he found it easy to overcome that slight difficulty. By applying a strong lens to the lamp it was possible to see the cap very much more easily than without its aid. The use of sodium in the safety lamp as suggested by Dr. Cadman and the author, was an excellent idea, even from a practical point of view, but after a certain number of applications its virtues disappeared.

In the old days before safety lamps were invented men had to go into mines, where gas existed, with ordinary candles. Those men carried their lives in their hands, but they were a deal better men at looking for gas than the miners of the present day, because they did their work more carefully. Men nowadays could sometimes be looked after too carefully. Things were made too soft and too luxurious for them, and they did not do their work as well as they used to for that reason. The miner shaded the candle with his hands, and he could tell when he began to get into a dangerous zone by the pulling up of the flame. He recently came across an appliance that a man had designed in the north of England as another among the many instruments for detecting fire-damp. The length of the ordinary flame of the safety lamp in pure air was increased when introduced into a small percentage of fire-damp, and this increase could be measured by means of a scale in the lamp. The truth of the matter was that they were driven back to the common ordinary safety lamp for the safety of the mines as they existed to-day. It was no good having skilled men going about in mines with fine apparatus which was used in one or two places, and then to leave the miner for the rest of his hours of work in his working place with nothing else to guard him than the ordinary safety lamp. That was the weakest link in the chain. Mine-managers might send as many apparatus as they liked into the pit; but if they left the man to work with the safety lamp, it was on the safety lamp they depended.

If all the talent of scientific people were devoted to producing a safety lamp which would go out when it reached the standard of ventilation, so that the miner was left in darkness, the most useful apparatus that could possibly be employed in mines would be evolved—a common or garden safety lamp that would go out when, say, three per cent. of gas was reached. Another interesting point was as to where they should look for gas in a pit. It was useless for a man to describe how wet a room was if he put his head under a small trickle of water coming from a tap in the corner of the room, because that would not be a very dangerous quantity of water. Exactly the same applied to a mine, except that the gas in the mine, instead of coming out of the side of the wall and falling as the water did, came out of the side of the wall and rose, and it was possible with any of the appliances which had been shown to have an indication of gas close in the face, right up in the roof, which would betoken a dangerous quantity if it were somewhere else, but which was not dangerous in that particular point. All those things ought to be considered in the interests of the harassed officials of mines. Every possible consideration ought to be given to mine-managers and mine-overmen in view of the great responsibilities that rested upon them, and the extremely onerous duties they had to perform, because after all they were only human beings.

Sir Henry Cunynghame, in reply to Mr. Blackett, said it was quite true that when a candle was put into an atmosphere in which there was methane the flame lengthened. Mr. Patterson had invented an apparatus in which a magic-lantern representation was passed through a lens on to a sheet, an observation being taken of how high the flame rose above a standard amount. The difficulty arose, what the standard amount was to be. The lamp had to be turned up first of all to the standard amount A, and an observation had to be made of how much higher the gas made it go. Turning it up to the standard A involved having the lamp trimmed in a particular way, and the admission of air quite free from methane. That gave the standard. If the lamp was taken from air that had no methane, into air that contained methane, the amount of the rise of the lamp could be proportionately obtained, and it afforded a fair method of getting the test, but the difficulty was, how were they to be sure of the standard? How were they to be sure that in the roadway, for instance, away from the dangerous places, air was obtained free from methane? If they could be sure of that, they had a standard; if not, they had not. That always appeared to him to be a difficulty in the use of a lamp of that form. The remarks Mr. Blackett had made with regard to lenses were excellent, but the reason why a lens was not of itself sufficient was that the light must be turned down. One of the chief objects in the new lamp designed by Professor Cadman and himself, was not to force the miner to turn his lamp down. The lamp could be kept up, and there was no danger of losing the light; and that consequently remained an advantage which all lamps possessed in trying to make the cap luminous. Mr. Blackett would be the first to admit that the turning down of the lamp was a decided disadvantage, particularly if the lamp wick happened to be dirty and had been alight for some time; it made men shirk, if they could, the duty of testing for gas. So that although it was quite true that it was an excellent thing to have a lens to add to the lamp, he still thought it was desirable that, whatever means were adopted in the future for detecting gas, it should be done without having to lower the flame. Whilst he had the greatest admiration for any apparatus that could be profitably used by overseers and overmen, he thought it very desirable that an apparatus should be in the hands of a great many

of the workmen which could be fixed on to the ordinary lamp they carried about, and used, if the occasion arose, at once without in any way detracting from the use of the lamp as an ordinary light-giver. If it could be fixed into the lamp it was a handy little apparatus by which the presence of gas could be detected immediately. Professor Cadman and himself had made a great many experiments with regard to the burning off of the sodium, and found that sixty hours' continuous burning could be obtained before the sodium was exhausted; so that its durability was manifest when one bore in mind that a test lasted only about three minutes. Uralite soaked in carbonate of soda was the best substance to use, and he believed he was safe in saying that once a piece had been soaked it would always produce a flame. If it were used for years he believed it would still show one, though he admitted it was better to have a fresh piece. Another advantage of the new appliance was that it could be used in both ways. He had taken the new lamp down into mines, and found that half per cent. could be seen without any difficulty at all; and it took a very keen eye indeed to see half per cent. with an ordinary miners' lamp. He had often turned the new lamp off and turned the old one on in order to compare the two results, and it was always possible to fall back upon testing in the ordinary way.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Sir Henry Cunynghame for his interesting Paper, and to Professor Cadman for his valuable aid in the experimental illustrations.

RUSSIAN FURS.

For the past two centuries a trade in furs has been carried on between Russia and other countries. London is the largest and most important fur-distributing point in the world, followed by Leipzig, a large market for European, American and Asiatic furs; Nizhni Novgorod, renowned for its annual fairs, which are visited by thousands of buyers and sellers from Europe and America; Irbit, also noted for its annual fur fair; Kasan, whose trade is almost exclusively with the dealers from Siberia; Kiachta, near the Siberian-Chinese boundary, and Astrakhan, at the mouth of the Volga, noted as the distributing point for Persian lamb skins, gathered from Persia, Syria and Bokhara, and worn throughout the civilised world. Tiflis, Kharkov, Baku and Archangel are also important outlets for furs produced in their respective provinces. The principal furs produced in Russia are the ermine, sable, sea otter, beaver, mink, musquash (musk-rat), squirrel, fox, skunk, marmot, weasel, badger, minever, rabbit and hare. Ermine is the highest priced of all furs, and although worn in general is regarded as a "royal fur." It is found in the north of Russia and Scandinavia, the most excellent quality coming from Ischim and Barabinsk, Siberia. According to the American Consul at Moscow, the ermine becomes pure white in winter in those snow-covered regions, where, if it retained its summer hue, the fact would render it an easy prey to its enemies. The tip of the tail alone remains black. Trapping ermine is carried on in winter, of necessity; in some localities they are shot with arrows in order to prevent the possibility of damaging the beautiful and costly coat. The skins rarely measure over a foot in length, and are disposed of by the trappers in lots of forty. The Russian sable, derived from the marten, while not so valuable as the ermine, is costly enough to prevent its becoming common. The skins range in size from fifteen to twenty inches in length, and from five to eight inches in breadth. In a genuine sable the outer covering of hair is especially delicate in quality and beautiful in colour, it being of a rich blue tint, varying from one and a half to two and a half inches in length, while the felt is very soft, but at the same time durable. The value and grades vary according to the district in which they are found, the highest quality being found in Yakutsk, the next best in the Lena River district, while the inferior are bought in the Lower Amur region. The Kamtchatka sable, more brown in colour than others, is regarded highly by the Russians. The sables are disposed of mainly on the London market, where they are distributed for sale in Europe and the United States. The tails are utilised for artists' brushes, but many so-called sable-hair brushes are made from the tail-hair of the Kolinski or Tartar sable. Mink furs are also sold to those unacquainted with these articles for sables, and so are the Tartar sables, which are brought in large quantities from Tartary and Siberia. The Tartar sable is a member of the squirrel family, and, while the coat is brilliantly yellow in its nature state, it is dyed to resemble the colour of the genuine sable, and can hardly be distinguished in many instances. Sable is also imitated by some exporters in Russia in the sale of dyed hare, rabbit, musk-rat and marmot skins, but the imposture is detected by legitimate and reliable dealers. The sea otter fur is highly prized in Russia, where it is used in the manufacture of caps for men and women, and for trimmings, coat collars, and the like. The sea otter is found in Kamtchatka, and is captured in large quantities by hunters and trappers. Large numbers of sea otter furs are also imported into Russia from Canada. It has been estimated that more than 30,000,000 squirrel skins find their way from Russia each year to the markets of the world. The grey fur is in demand for general uses, for cloak and coat linings. Another member of the squirrel family found in eastern Siberia, regarded with even more favour than the grey variety, is the blue squirrel, whose colour varies from dark to light, according to the season of the year. The tails are longer and more bushy than those of the grey squirrel, and are made up in boas, or used for artists' brushes. The beaver skin, while produced in some

parts of Russia, is mainly imported from North America. The musk-rat is found in large quantities along the Volga and its tributaries, and is considered the easiest fur-bearing animal to trap. The mink's beautiful brown coat is much in demand, the fur being especially suitable for muffs and other articles. In point of commercial value the fox is only surpassed by the sable. The Russian fox has not the high quality that is found in those brought from Labrador; the silver fox fur is in universal demand. Rabbit and hare skins are to be found in all the cheap markets, but their commercial importance ranks high because of their universal use among those who cannot afford high-class skins. The fur of the white Arctic hare is often disposed of as genuine fox, but an expert can easily tell the difference. The value of furs exported from Russia in 1909 amounted to £1,250,000.

THE AMERICAN CHRISTMAS-TREE INDUSTRY.

The United States requires annually not less than 4,000,000 Christmas trees, and there is little doubt that the present indiscriminate cropping, every year, of many young evergreens for Christmas trees has produced, in many cases, a bad effect on the future timber supply. If the woodlands were under a proper forestry management, no harm would be done, for the yearly thinning of the forests would satisfy even a greater demand for Christmas trees than now exists. It is frequently found, in Maine and the Adirondacks, the principal sources of supply of Christmas trees, that there are as many as 50,000 to 100,000 young seedlings on an acre. The use of small evergreens for Christmas trees offers, therefore, an excellent opportunity for the improvement of the forest by thinning. Every winter, at the time Christmas trees are beginning to be in demand, thousands of spruce and balsam fir trees are cut throughout Maine, New Hampshire, Vermont, and New York, for lumber and pulp. The trees are never taken below four inches in diameter in the top. Thousands of the tops of spruce and balsam fir trees are consequently left every year in the woods to rot, and serve as fuel, when they would make excellent Christmas trees. According to the United States Department of Agriculture, practically all conifers can be, and are, used as Christmas trees, but the most popular ones are the firs, spruces, and to a less extent the pines and cedars. The use of one or other evergreen for this purpose, depends frequently upon its accessibility, particularly in the mountainous districts of the country. Thus, for instance, in Colorado, where fir is abundant, but grows at high altitudes and therefore is difficult to get out, the lodgepole pine growing at the foot of the mountains, and the Douglas spruce, are more frequently used than the fir. The latter is undoubtedly the Christmas tree *par excellence*, especially in the north-eastern and Lake states. The spruce vies with the fir in popularity as a Christmas tree, but as a rule, in the south and west, they grow at high altitudes, which makes them also difficult to get at, and are therefore replaced by less suitable, but more accessible conifers. Black spruce is the tree chiefly found in New York and Philadelphia. Throughout the States of Illinois and Ohio, nurserymen supply the local demand with nursery-grown Norway spruce. The pines are in great demand for Christmas trees when fir and spruce are not available, or are only to be had at a high price. Throughout Maryland, Virginia, and in Washington, the scrub pine finds a way into many homes for use in this capacity, while in southern Wyoming the lodgepole pine is almost the only species available for Christmas trees. The centre of the Christmas-tree industry lies in the large cities of the east. New York City and the New England States consume 1,500,000 trees, or nearly half of all the output. Maine, New Hampshire, the Berkshire Hills in Massachusetts, the Adirondacks, and the Catskills in New York, are the sources of supply for New York, Philadelphia, and Boston, and even for Baltimore and Washington. The swamps of Michigan, Wisconsin, and Minnesota furnish the markets of Chicago, St. Paul, and Minneapolis. The sizes of Christmas trees vary from five to thirty-five feet in height. Usually short-pointed, stocky trees with thick branches at the base of each annual growth, are the most sought for. The sale price varies, being dependent upon the demand and supply. Ordinarily small trees, five to six feet high, are sold for about one shilling in the city markets, while a tree from six to ten feet high brings four shillings or more, according to its symmetry. Large, shapely trees are sold in New York City at from one pound to six pounds each, and trees thirty-five feet high bring as much as seven pounds each. The average run of prices is from a minimum of one shilling to a maximum of one pound for a tree. There is very little profit in the business for those who furnish the material. These are mostly farmers who look upon the trees as a gift of Nature, and in selling them consider only the labour of cutting and hauling, and not the labour and expense required to grow the trees. For trees which in the cities bring one shilling, the farmers get about twopence halfpenny. Trees sold in the cities for about six shillings a-piece, bring them only about sevenpence halfpenny. This, of course, only refers to the large cities. In small towns the demand is supplied by the farmers directly, who cut down the trees and hawk them from house to house. When the market is not glutted, the dealers make large profits, sometimes as much as two hundred or three hundred per cent. on their outlay, but when the supply exceeds the demand they are apt to suffer losses, and frequently resort to the destruction of many thousands of trees in order to keep up prices. Balsam firs of the sizes used for Christmas trees can be grown in about fifteen years. Allowing for each tree a space six feet by seven for a good development of the crown, there may be expected at this age over one thousand

trees, of sizes varying from eight to fifteen feet in height, on an acre. Such trees bring in the cities from six shillings to twelve shillings each.

YERBA MATÉ, OR PARAGUAY TEA.

Yerba maté, or Paraguay tea, is the daily household beverage of the masses of Paraguay, and it is consumed to a great extent also in Brazil and Argentina. It has been introduced into Europe, where its use is increasing. This tea is the product of a plant belonging to the species Ilex, an evergreen shrub or small tree, well known in western Europe. The leaves of this plant are carefully toasted near the place where they are gathered, all the skill required in producing the tea being applied in the process of toasting. This is necessary in order to dry the leaves thoroughly and evenly, without scorching or affecting their flavour by smoke. After toasting, the leaves are sent to the mill, where they are ground to fine powder and packed solidly into bags for market. According to the United States Consul at Asuncion, the tea is prepared for drinking in Paraguay in the same manner as ordinary tea, and may be taken with sugar, cream, lemon or brandy. The universal manner of drinking it is by sucking it through bombillas from maté cups. A bombilla is a tube, which may be of the simplicity of a mere pipe stem or an elaborately decorated silver or silver-mounted work of art. Maté cups vary in style from a simple little gourd to interesting specimens of local craftsmanship in silver. It is the custom to use a single maté cup, with its one bombilla, for an entire household, including all the visitors who may happen to be present, among whom it is passed like a pipe of peace. To refuse to partake would be a breach of etiquette. As an article of commerce, Yerba maté has steadily increased in importance, until it has become one of the leading exports of Paraguay, ranking fourth in value in 1909, when the exports amounted to £110,000. In July 1910 the entire product of the country for the year had been sold.

THE FRENCH WINE INDUSTRY.

It is evident that of late years the interest in viticulture has been steadily decreasing, with the result that in 1909 France imported 137,000,000 gallons of wine. The decreased production of wine in recent years is due, in part at least, to the law passed by the French Parliament on July 29th, 1907, regulating the watering and sugaring of wines, but this law had the wholesome effect of assuring a better quality of wine and higher prices for the producers, as well as effectively suppressing frauds which had sprung up in the making of wine. The area devoted to grapes in 1875 was 5,982,000 acres, and in 1909, 4,015,000 acres; the decrease between the years given has been steady and continuous. The abandonment of large tracts of vineyards in France on account of the ravages of the phylloxera is not distributed uniformly throughout the country, but is peculiar to only a number of Departments, in some of which viticulture has been almost entirely abandoned, while in others there is no apparent loss in the area devoted to that industry. The south-west portion of France, known as the "bassins" of the Garonne and Charente, comprising eleven Departments, has suffered a reduction of nearly 50 per cent. since 1875. Where the Departments of Charente counted 655,815 acres thirty-five years ago, to-day they have not more than 195,209 acres. The grape crop of Charente is not all converted into wine for present consumption, but is used almost exclusively for the production of cognac. The Midi region, which comprises the six Departments of the Mediterranean coast, has suffered only a small diminution of its vintage acreage, due to the fact that the planters, when the invasion of the phylloxera came, were able to combat it by substituting the more hardy American plants for the native vine. The wines of this region are known to be very thick and heavy. In the eastern portion of France, and the valleys of the Rhône, Beaujolais and Bourgogne, comprising six Departments, nearly one-fourth of the area has been abandoned by the wine-growers during this period of thirty-five years. In the valley of the Loire, comprising six Departments, there has been a falling-off of 383,000 acres, or about one-fifth during the thirty-five years' period. The United States Deputy Consul-General in Paris says that, notwithstanding the great diminution in the area of wine lands, the production has remained almost the same; in fact, for the last six years it has increased, owing largely to the healthy American plants which have been introduced into France, and which proved to have greater resisting powers against the ravages of the vine pests. It is interesting to note that, with the exception of 1875, the production of wine has steadily increased for the last sixty years. The region of the Midi, or the Mediterranean coast, comprising the Departments of the Pyrénées-Orientales, Aude, Herault, Gard, Bouches-du-Rhône, and Var, furnish more than one-half of the wine produced in France, their total production being about 645,000,000 gallons. The next most important is the south-west, or the valleys of the Garonne and the Charente, while the valleys of the Rhône, Beaujolais, and Bourgogne, in the eastern part of France, furnished nearly one-tenth of the wine harvest of 1909. Notwithstanding the abundant wine-harvests which France has enjoyed in the past, she has been compelled to import varying quantities of wine according to the supply at home. These importations have assumed significant figures from time to time, but have remained comparatively steady during the last three years. A large proportion of imported wines comes from Algeria, and as the wines from that place are very thin they are mixed with the heavy wines of the Midi. There are also considerable quantities of wines imported from Spain, Italy, and Portugal. The quantities of wine

imported into France during the last three years were as follows:—130,000,000 gallons in 1907; 152,000,000 gallons in 1908, and 137,000,000 gallons in 1909. There has been but little fluctuation in the amount of wine exported from France since 1888. In 1909 the quantity exported amounted to 55,000,000 gallons.

HOME INDUSTRIES.

The Cotton Crop.—The latest estimate of Messrs. Neill Brothers puts the American cotton crop of the present season at 11,600,000 bales, or a million bales more than last season's, but nearly two and a quarter million bales less than that of 1908-9. Three causes are given by Messrs. Neill Brothers for the comparatively small yield: (1) A long drought in Texas; (2) a late crop; (3) outside Texas, "a mysterious deterioration in the condition of the plant." Assuming that all the spindles of the world ordinarily using American cotton should work full time, Messrs. Neill estimate that they would want 13,550,000 bales this year. But, of course, full time everywhere is not to be expected, and if it occurred there would soon be a plethora of cotton goods. Fortunately the Indian and Egyptian crops are reported to be very good, and they will relieve the American crop. The Alexandria General Produce Association have estimated the Egyptian crop at 7,000,000 cantars, as against 5,000,000 cantars last season. On the whole, Lancashire spinners are taking a hopeful view of the outlook, and it is a reasonable expectation that though there must be some short time, it will be much less than in the past season.

The Uses of Cotton Seed.—The Publicity Committee of the Cottonseed Crushing Association of Georgia is doing its utmost to make known the use and importance of cotton seed products, and Dr. A. N. Soule, President of the Georgia State College of Agriculture, is writing a series of leaflets with the object of making the various properties of cotton seed better known. He says that cotton seed has risen in forty years from a position of uncertainty to being the basis of an industry of international importance. Its remarkable enhancement in value is not hard to understand when its chemical analysis is taken into consideration. Nearly 20 per cent. of cotton seed consists of oil, which, when properly refined, supplies the housewife with an admirable substitute for lard. "Through a wise provision of Nature," writes the doctor, "which man has been slow to appreciate, the oil consists entirely of carbon, nitrogen, and oxygen—three elements which plants secure chiefly from the air—and water which falls as rain." Dr. Soule continues in the same strain when describing the uses of cotton seed products:—"It is not difficult to see the important part which cotton seed plays now. and is destined to exercise in the future development of the live-stock industry of the south, and in the maintenance of soil fertility on that high basis essential to the production of maximum crops at a minimum cost."

Wool Supplies.—It looks as if wool supplies will be very ample this year. In the first four months of the present wool year, that is to say from July 1st to October 31st, the exports from Australia amounted to 463,000 bales against 391,000 bales for the corresponding months of last year, the increase being no less than 72,000 bales, of which 58,000 are to be credited to October alone. It is expected that this increase will be nearly doubled this month, and that the increase will be continuous until the end of the wool year, when it will probably amount to close upon 200,000 bales. Messrs. Dalgety report that, "The new clip is in some respects disappointing, for whilst the quality and softness of handle are above the average, many of the Riverina wools are shorter in staple, and all of them much more burry than last season. As regards condition, they vary considerably, but most of the clips offered by us to-day were no heavier than they were last year." It is reported from South Australia that Booboorowie South, belonging to Mr. A. S. Browne, and consisting of about 30,000 acres of splendid land, is about to be placed on the market, which means that the well-known clip of wool marked Browne, over Booboorowie, so popular for seventy years past with Bradford combers, will become a thing of the past. Mourak, too, which belonged to the late Colonel Browne, lost in the *Waratah*, is to be sold, and there will be an end of the famous Mourak clip of greasy Lincoln wool.

Carpet Yarn Contracts.—The judgment of Mr. Justice Hamilton in the action brought by the Chlidema Carpet Company of Kidderminster against a firm of spinners at Leicester for alleged breach of contract in the non-delivery of yarns and woollens clears up a point which has been the subject of much controversy. Mr. Justice Hamilton has ruled that "all open contracts in the section of the spinning trade connected with the supply of Kidderminster must be completed within one year." Mr. Justice Hamilton based his decision on the declaration in the Sale of Goods Act, which states that contracts must be completed "within a reasonable time." In the Bradford district specific periods have for some time been arranged in connection with delivery. A year certainly seems sufficiently liberal to meet the condition, "within a reasonable time."

The Shipbuilding Crisis.—The repeated refusal of the boiler-makers to authorise their leaders to give adequate guarantees that bargains will be observed in future, has led to an unprecedented situation. The employers say the lock-out must continue until such guarantees are given, the Society declares that it will not give these guarantees. The executive council of the Society wishes to give them but cannot without the authorisation of the men, which continues to be withheld. Hence deadlock. It looks as if the Society

must split up, since it can no longer make any contract with the federated employers. Possibly the considerable minority in favour of supporting their leaders will secede and form a new organisation of their own. The shipyards have had to pay off large numbers of wood-workers, for whom they can no longer find employment while the iron-work at the shipyards is at a standstill. Next we shall hear of the closing of the engine shops, which have been kept going in the expectation that the shipyard stoppage will soon be over. A number of steelworks have been closed down and the iron-works must follow suit. It is most lamentable. There is work in abundance to be done, yet all sorts of workers are idle because the majority of the boiler-makers refuse to be bound by the undertakings entered into on their behalf by their own leaders.

The Welsh Coal Strike.—It is to be feared that the Welsh coal strikes are not at an end. As soon as a settlement is reached in one district unrest develops into defiance in another. The strike in the Rhondda Valley was accompanied by scenes of violence, with which happily the country has been unfamiliar in recent years. The men marched from pit to pit compelling the engineers to cease work in the power-houses, many of which were wrecked. There was rioting for several days. Strangers were stoned, the shops looted, windows broken, stores distributed or scattered in the streets. Perhaps the most repulsive incident of all the lawless proceedings was the refusal of the rioters to permit the descent into the mines even of the ostlers, whose duty it was to feed the pit ponies. Hundreds of these poor animals in the various pits were left untended, without food or water, for four days. More wanton, deliberate, and callous cruelty it would be difficult to imagine.

Cheap Electric Lighting.—An interesting experiment in electric lighting has been tried at Eccles. The Electricity Committee thought it might be possible to provide electric lighting at sixpence a week for small houses. It was calculated that if, instead of every house having a separate service and meter with low-tension distributing mains, the landlords of rows of houses would instal the wirings and fittings (as some landlords do) and would also buy the electricity in bulk for the whole row, a charge of sixpence a week for each tenant would pay. The experiment was tried in a dozen cottages which were being built by the Health Committee, and has shown that the lighting yields a profit. But to make it possible the electricity must be supplied through one meter to a whole row of cottages, so that it is impossible to charge each tenant in exact proportion to what he uses. Here is perhaps the weakest point in the arrangement, but the experiment was a very interesting one, and it may be hoped that it will be tried by other electricity committees, and that builders and landlords will take note of it.

Ratner Safes.—Like most honest folk, the burglar is quick to take advantage of the discoveries of science, and his latest device is the oxy-acetylene blow-pipe, which will cut through any hitherto known form of wrought steel or iron without difficulty up to a thickness of several inches. Safe-makers have been trying for some time past to invent some means of rendering the blow-pipe inoperative in the case of bankers' and diamond merchants' safes, and strong-room doors and the Ratner Safe Company, Limited, claim to have achieved success with a special flame-resisting metal which absolutely nullifies the destructive power of the oxy-acetylene gas-flame. Messrs. Ratner's No. 7 quality patent bankers' strong-room doors are constructed with their special flame-resisting metal in the following manner:—½ in. drill-proof steel outside, ¾ in. special flame-resisting metal next, and ⅜ in. inner lock case and insertion plate, making a total thickness of 1⅝ ins. The experiments seem to have been very complete and satisfactory.

An Insurance Scheme.—Among the latest of many attempts to meet the case of persons who are anxious as to their ability to maintain the regular payment of premiums is a modification of the system of insurance by single premiums. Under this scheme an amount equal to 5 per cent. of the single premium chargeable for a given amount of insurance is paid on acceptance of the proposal, and the balance of 95 per cent. is payable in such instalments and at such periods as may be convenient to the assured. Interest on the balance of premiums remaining unpaid is charged at the rate of 4 per cent. per annum less income tax. In this way all the benefits and options attaching to a fully paid-up policy are secured to the assured from the outset, subject only to the debt represented by the amount of premium remaining due. The policies rank for the full sum assured at bonus distributions.

CORRESPONDENCE.

A PNEUMATIC RESPIRATOR.

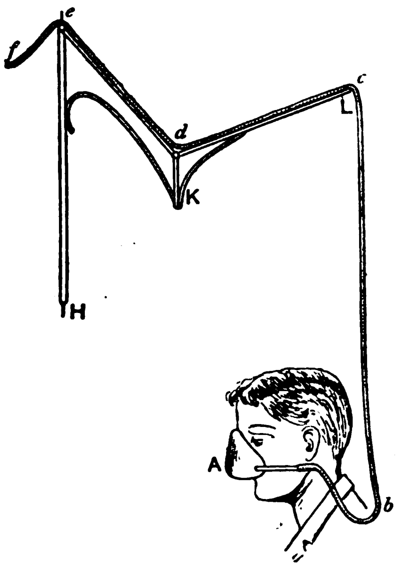
A recent visit to the granite-working factories in the city of Aberdeen has suggested to me the following arrangement for the prevention of inhalation of the dust by workmen. It is applicable to dust or fumes of all sorts, whether heavy or light.

Respirators, as is well known, are very oppressive to wear. If they are too porous, they do not arrest the dust; if they are sufficient to arrest the dust, they impede respiration to an extent that renders them almost unbearable to a man who is doing hard work, and they cause the exhaled breath to be breathed over again.

To obviate these inconveniences, I suggest the following plan:—

Let the respirator consist of a copper-shaped

vessel put over the nose and mouth, and with the edges bent so as roughly to fit the face. Around the interior edges fit some strips of fur, such as that of a rabbit or cat, sufficient to fill up the interstices between the face and the copper vessel. Into the vessel lead a small metal pipe fitting on to a rubber pipe attached to the reservoir of an air bellows. The rubber pipe is to lead up about six feet, and then be tied to a movable jointed bracket up near the ceiling of the room. By this arrangement the workman can move freely about and bend his head. The air, rushing in from the air-receptacle of the bellows, fills the copper vessel, supplies what he needs for breathing, and escapes through the rabbit skin at the sides. It is impossible for any dust to be inhaled. It will not do to work such a respirator from the air-compressors that are used in driving the pneumatic granite-



A. Copper mask.
b, c, d, e, f. India-rubber pipe.
H, K, L. Jointed bracket to carry the pipe and allow the man to move about. The bend at *b* may of course be bigger, so as to go partly down his back and up again.

dressing tools, firstly because it becomes icy cold as it expands, and secondly because it is impregnated with oil.

Nor is this needful. A bellows of wood and leather, drawing the air from some pure source, at a pressure of some 3 or 4 lbs. to the inch, is all that is needed. Inside the mask the air would, of course, have the effect of continually clearing away the exhaled breath, so that at each breath the workman would breathe fresh air, and not, as in a respirator, keep continually inhaling air already contaminated by his breath.

A rough trial in a factory has convinced me of the practicability of this method, and I desire to place it on record in the *Journal* of the Society, so that it may become public property, and free to anyone who chooses to use it.

HENRY CUNYNGHAME.

NOTES ON BOOKS.

HAND-LOOM WEAVING. By Luther Hooper. London: John Hogg. 6*s*. net.

Though the ancient craft of the hand-loom weaver is, to a large extent, obsolete in this country, it still exists in some places as a survival, in others as a revival. The substitution of mechanical for hand power, and the application of the steam engine to drive the loom at the end of the eighteenth century, rendered the old apparatus almost worthless, and ruined those who for centuries had lived by working it. Hand-weaving may have persisted as a domestic industry for a little after it had perished as a commercial one, and in the most outlying districts it has persisted to our own days. It has also been continued for the production of costly and beautiful fabrics which cannot be wrought in the machine-loom, or for which there is not sufficient demand to make their manufacture profitable on the large scale.

Perhaps it may be the revival of the art of recent years that has led to the issue of the present work; but whether this be so or not, it may certainly be commended, not only to the limited band of hand-loom workers, but to all who are interested in the textile industries.

The book (like ancient Gaul) is divided into three parts. The first deals with plain weaving, and gives a technical description of the loom and the various subordinate appliances; the second is devoted to simple pattern-weaving; and the third to complex pattern-weaving. It must be remembered that the machine-loom is not included, and there is consequently nothing beyond a mere reference to the Jacquard apparatus.

The book is throughout very fully illustrated, the illustrations in the first part including a number of pictures of various forms of old and simple weaving appliances.

JOURNALS AND REMINISCENCES OF JAMES DOUGLAS, M.D. Edited by his Son. New York: Privately printed.

It is impossible to read these interesting pages without being impressed anew by the great changes which have taken place in our life and civilisation during the last century. James Douglas was born in 1800. At the age of thirteen he was bound as an apprentice to a doctor in the Lake district. "During the second year of my time I had charge of the surgery, and made up the prescriptions. I had to visit the pauper class, as well in the country as in the town, and to report on any emergency or on the appearance of any grave symptoms . . . As perquisites, I had the shilling which was the fee for blood-letting or tooth-drawing. That for blood-letting particularly was very remunerative, as it was the custom of the country people generally to be bled every spring,

and of many, every spring and autumn. These perquisites, during three and a half years of my apprenticeship, rendered me independent of my father for the expenses of clothes and pocket-money."

On completing his apprenticeship, Douglas proceeded to Edinburgh, whence he finally graduated M.D. Before that, however, whilst still a medical student, he was offered an appointment as surgeon of a whaling ship, and at the age of eighteen he sailed for the Arctic seas. The short journal of this voyage is full of interest, telling as it does of the days before the coming of the machine-gun and the explosive harpoon, when whaling was a very perilous calling, and the boats were often smashed to pieces by the flukes of the struggling monster.

After graduating at Edinburgh and attending various lectures in London, Douglas accepted a temporary appointment at Dum Dum, near Calcutta, and he has some interesting pages on India in 1821. At that time Sutteeism was rampant. Douglas himself saw many cases of it—on one occasion witnessing two which were being conducted simultaneously—and he states that between 1804 and 1829, when the practice was declared illegal, seventy thousand widows were burnt alive in India. He also gives a lurid description of the state of the Ganges below Calcutta. So many dead bodies were flung into it that "as the ships lay off the different Ghats, the bodies frequently got across the cables, or the vessel's bows, and a dingie-wallah was stationed at each Ghat, whose sole duty it was to clear the bodies and pass them on."

Having spent a year in India, Douglas proceeded to the West Indies, where he was placed in medical charge of the Poyais settlement on the coast of Honduras. This was one of the many colonisation projects organised by promoters who took advantage of the enthusiasm excited by the struggle between Spain and her American colonies. The experiences of the unfortunate Poyais settlers were terrible. They found themselves dumped on the swampy lands at the mouth of the Black River, on a spot bearing the ill-omened name, Mosquito Shore. Here they had to contend with almost every calamity and privation that can befall the pioneer—hurricane, want of food, and sickness, which sometimes was so deadly that every person in the settlement was sick at the same time. A large percentage of the colonists died, and Douglas himself only escaped after a very severe illness.

It is not possible within the limits of these Notes to follow Douglas further in his wanderings, or to mention scores of incidents which throw a sidelight on the medical profession as it was practised half a century ago. Suffice it to say that he finally established himself in practice in Quebec, where he soon made a name as the foremost Canadian surgeon of his day. On one occasion he carried out the whole operation of amputating a leg in one minute and forty-two seconds, a speed that must have been of incalculable service to his patients in a day when anæsthetics were unknown.

The book has been excellently edited by Dr. Douglas's son, Professor James Douglas of New York, whose Cantor Lectures and papers on various mining and metallurgical subjects must be familiar to many members of the Society.

GENERAL NOTES.

The Birds'-nest Industry in Siam.—Birds'-nests form a singular item in the export trade of Siam, the shipments during the fiscal year 1909 amounting to 17,781 pounds, valued at £22,000, most of which was taken by China, Hong-Kong and Singapore. These edible nests are found in the islands off the coast of Siam, and are the products of a species of bird belonging to the family of swifts. The nests consist almost entirely of the salivary secretion of these birds, whose salivary glands are much more developed than those of the ordinary swift. The season for the gathering of the nests begins in April and ends in September. The female bird, occasionally assisted by the male, makes the nest. About three months are spent by the birds in completing their first nest, which is taken by the nest-gatherer before eggs are laid in it; then the birds immediately begin to make another nest, which is finished in about thirty days, and which is also taken. Finally, a third nest is made in about three months, in which the bird is allowed to rear its offspring, after which this nest is also gathered. Each family of birds thus furnishes three nests in one season. The nests taken at the beginning of the season are considered the best in quality. The Chinese, who consume these edible nests, regard them not only as a great table delicacy but also as a valuable tonic medicine.

Coach-building Prizes.—The Worshipful Company of Coach Makers and Coach-harness Makers of London offer the following prizes for competition among British subjects engaged in coach and coach-harness making and motor-body making, and members of drawing and technical classes in connection with such trades, resident in the United Kingdom of Great Britain and Ireland:—Competition No. 1 (open to all)—The Master, Mr. Arthur Strachan Winterbotham, offers £10 10s., and the Company £5 5s. and their silver and bronze medals, for a full-sized working drawing—side view only—of a Limousine motor carriage-body with completely enclosed front and two entrances at either side. To seat six persons, with opening glass wind-shield over dash; the drawing to show position of hind wing and wheel; designed for any known type of motor chassis of not more than 10 feet 6 inches wheel base; chassis not required; in pencil, on paper 11 feet by 7 feet. Original improvements will receive special con-

sideration. 1st prize, the Company's silver medal and £10 10s.; 2nd prize, the Company's bronze medal and £5 5s. Competition No. 2 (open to all)—For a set of four scale drawings—*i.e.*, off-side (showing levers, pedals and steering-wheel), sectional, half-rear and half-plan views—of a completely enclosed two-seated motor carriage-body (without interior upholstery); the leather hood and front screen to fold to form an entirely open carriage; the sectional drawing to be a perpendicular section taken lengthways through the middle of the body from front to back; consideration to be given to easy access on the off-side; designed for any known type of motor chassis of not more than 9 feet 6 inches wheel base; details of chassis other than specified not required; scale, 1½ inches to the foot; in ink, on paper 48 inches by 36 inches. Original improvements will receive special consideration. 1st prize, the Company's bronze medal and £5 5s.; 2nd prize, £3 3s. Competition No. 3 (open to journeyman harness-makers)—For the best single harness bridle, brass furniture, small cheek loops, black patent leather front and rosettes, for use without bearing-reins; no bit or monogram or crest on winkers required; to be the work of one man. It is suggested that harness-making firms assist by allowing competitors to effect the work where employed. 1st prize, the Company's bronze medal and £4 4s.; 2nd prize, £3 3s. Competition No. 4 (open to body-makers)—For a full-size model of portion of a carriage door fitted with a slam lock and with part of the front pillar and front cross-bar against which it shuts; to be put together with screws, so that it can be taken to pieces to inspect the joints and fitting of casing board; the whole not to exceed 16 inches long or wide. Original improvements will receive special consideration. It is suggested that carriage-making firms assist by allowing competitors to effect the work where employed. 1st prize, £4 4s.; 2nd prize, £2 2s. Competition No. 5 (open to youths under twenty-one years)—For a side view and half plan of a square landau, 5 feet 3 inches on elbow line, suitable for one horse; scale 1½ inches to the foot; in pencil, on paper 27 inches by 18 inches. 1st prize, £3 3s.; 2nd prize, £2 2s.; 3rd prize, £1 1s. Each of the prizes will be accompanied by the certificate of the Company.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock :—

November 30.—Campbell P. Ogilvie, "Argentina from a British Point of View." Sir Alexander Henderson, Bart., will preside.

December 7.—Vaughan Cornish, D.Sc., F.G.S., F.C.S., "The Panama Canal in 1910." Sir William H. White, K.C.B., F.R.S., will preside.

December 14. — Reginald A. Smith, B.A., F.S.A., "A New View of Roman London."

Colonial Section.

Tuesday afternoon, at 4.30 o'clock :—

November 29.—A. Montgomery, M.A., F.G.S., "The Progress and Prospects of Mining in Western Australia." Admiral Sir Frederick George Denham Bedford, G.C.B., will preside.

Indian Section.

Thursday afternoon, at 4.30 o'clock :—

December 15.—Robert Fellowes Chisholm, F.R.I.B.A., F.S.A., "The Taj Mahal and its Relation to Indian Architecture."

Cantor Lectures.

Monday Evenings, at 8 o'clock :—

Charles R. Darling, A.R.C.Sc.I., F.I.C., "Industrial Pyrometry." Four Lectures.

Lecture II.—November 28.—Laws of thermo-electricity — Thermo-electric pyrometers of Le Chatelier and Roberts-Austen—Temperature indicators—Recorders, ink and photographic—Arrangement of a number of pyrometers centrally controlled —Determination of the critical points of steel—Application to hardening and tempering—Limits of use.

Lecture III.—December 5.—Laws of resistance to electricity—Siemens' resistance pyrometer—Callendar's pyrometer — Principles of resistance measurement—Temperature indicators for resistance pyrometer—Callendar's recorder—Northrup's recorder—Special uses and limitations of resistance pyrometers.

Lecture IV.—December 12.—Radiant energy—The "fourth-power" law—Laws of Wein and Planck—The Féry radiation pyrometers and indicators—The Holborn-Kurlbaum optical pyrometer —Wanner's pyrometer—Other optical pyrometers —Special uses of radiation pyrometers in pottery manufacture and work at very high temperatures.

Papers to be read after Christmas :—

Horace M. Wyatt, "Motor Transport in Great Britain and the Colonies."

Philip Joseph Hartog, M.A., B.Sc., "Examinations and their bearing on National Efficiency."

J. C. Medd, "The Dutch Labour Colonies."

Cyril Davenport, "Illuminated Manuscripts."

George A. Stephen, "Modern Machine Bookbinding."

Professor J. Wertheimer, B.Sc., B.A., "Water-Finders."

Captain A. J. N. Tremearne, "Some Nigerian Head-Hunters."

Hon. Sir Richard Solomon, K.C.B., K.C.M.G., K.C.V.O., K.C., M.A., High Commissioner for the

Union of South Africa, "South Africa before and after the Union."

F. DOUGLAS OSBORNE, M.Inst.M.M., "The Tin Resources of the Empire."

REGINALD MURRAY, "Indian Banking."

R. A. LESLIE MOORE, I.C.S. (retd.), "Indian Superstitions."

Captain R. MUIRHEAD COLLINS, C.M.G., "Australia and her Resources."

FRANK M. ANDREWS, "Architecture in America."

ARTHUR CHARLES DAVIS, F.C.S., Assoc.Inst.C.E., "The Manufacture and Testing of Portland Cement."

GEORGE B. HEMING, "Art Education in Jewellery and Goldsmithing."

Colonel CHARLES EDWARD CASSAL, V.D., F.I.C., "The Adulteration of Food."

Dr. LEONARD HILL, F.R.S., "Caisson Sickness and Compressed Air."

Sir WILLIAM ABNEY, K.C.B., D.C.L.. D.Sc., F.R.S., "The Quantitative Measurement of Colour-Blindness."

HAL WILLIAMS, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

January 19, February 9, March 16, April 27, May 25.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

January 31, February 28, April 4, May 9.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

FREDERICK WEDMORE, "Etching": 1. "The Old Masters;" 2. "Modern Etching." Two Lectures.

January 23, 30.

Professor ADRIAN J. BROWN, M.Sc., "Brewing." Four Lectures.

February 6, 13, 20, 27.

Professor J. A. FLEMING, M.A., D.Sc., F.R.S., "Applications of Electric Heating." Four Lectures.

March 6, 13, 20, 27.

ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

May 1, 8, 15, 22.

JUVENILE LECTURES.

Wednesday evenings, January 4 and 11, 1911, at 5 o'clock:—

Professor ARTHUR MASON WORTHINGTON, C.B., M.A., F.R.S., "A Study of Splashes, conducted by the aid of Instantaneous Photography." Two Lectures.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOVEMBER 28...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. C. R. Darling, "Industrial Pyrometry." (Lecture II.)

Surveyors, 12, Great George-street, S.W., 8 p.m.

Actuaries, Staple Inn Hall, Holborn, W.C., 5 p.m. Inaugural Address by the President, Mr. G. H. Ryan.

London Institution, Finsbury-circus, E.C., 5 p.m. Major Ronald Ross, "Malaria."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. A. Oliver, "Notes on Some French Churches."

TUESDAY, NOVEMBER 29...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Mr. A. Montgomery, "The Progress and Prospects of Mining in Western Australia."

Sociological (at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 8 p.m. Professor Michael Sadler, "The State and Education."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. Bamber's Paper, "Portland Cement, and the Question of its Aeration."

Photographic, 35, Russell-square, W.C., 8 p.m. Discussion on "Time Development," by Dr. Mees, Mr. W. B. Ferguson, and Mr. Alfred Watkins.

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. Mr. J. Ferguson, "Ceylon, the Malay States, and Java, Compared as Plantation and Residential Colonies."

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Dr. H. B. Fantham and Mr. H. Hammond Smith, "On a Possible Cause of Pneumo-enteritis in the Red Grouse (*Lagopus scoticus*)." 2. Mr. F. E. Beddard, "On the Alimentary Tract of certain Birds, and on the Mesenteric Relations of the Intestinal Loops." 3. Professor A. Cabrera, "On the Specimens of Spotted Hyenas in the British Museum (Natural History)." 4. Dr. J. F. Gemmill, "The Development of *Solaster endeca* Forbes."

WEDNESDAY, NOVEMBER 30...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Campbell P. Ogilvie, "Argentina from a British Point of View."

Cold Storage and Ice Association, Merchants' Hall, Baltic Exchange, St. Mary Axe, E.C., 8 p.m. Mr. C. T. Brightman, "Refrigerated Cargoes and their Insurance."

British Astronomical, Sion College, Victoria Embankment, E.C., 5 p.m.

THURSDAY, DECEMBER 1....Linnean, Burlington House, W., 8 p.m. 1. Captain C. F. U. Meek, "Spermatogenesis in Stenobothrus." 2. Dr. Otto Stapf and others, "Reports on the International Botanical Congress at Brussels, 1910."

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. M. O. Forster and S. H. Newman, "The Triazo-group. Part XV. Triazoethylene (vinylazoimide) and the Triazoethyl Halides." 2. Mr. W. J. Jones, "The Determination of Solubility coefficients by Aspiration." Preliminary note. 3. Messrs. F. D. Chattaway and M. Aldridge, "The Auto-reduction of Hydrazines." 4. Messrs. G. T. Morgan and A. Clayton, "The Nitro-Derivatives of Dimethyl-p-toluidine."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. E. W. D. Manson, "Imprisonment for Debt."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Dr. Francis Ward, "Phases of Fish Life and How to Record Them."

Roentgen Society, 19, Hanover-square, W., 8.15 p.m.

FRIDAY, DECEMBER 2...British Academy, in the Theatre, Burlington-gardens, W., 5 p.m. The Very Rev. George Adam Smith, "The Early Poetry of Israel in its Physical and Social Origins."

African Society, Trocadero Restaurant, Shaftesbury-avenue, W., 8 p.m. Sir George T. Goldie, "The African Society."

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FRIDAY, DECEMBER 2, 1910.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 5th, 8 p.m. (Cantor Lecture.) CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "Industrial Pyrometry." (Lecture III.)

WEDNESDAY, DECEMBER 7th, 8 p.m. (Ordinary Meeting.) VAUGHAN CORNISH, D.Sc., F.G.S., F.C.S., "The Panama Canal in 1910." Sir WILLIAM H. WHITE, K.C.B., F.R.S., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, November 28th, Mr. CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., delivered the second lecture of his course on "Industrial Pyrometry."

The lectures will be published in the *Journal* during the Christmas recess.

COLONIAL SECTION.

Tuesday afternoon, November 29th; Admiral Sir FREDERICK GEORGE DENHAM BEDFORD, G.C.B., late Governor of Western Australia, in the chair. A paper on "The Progress and Prospects of Mining in Western Australia" was read by A. MONTGOMERY, M.A., F.G.S., State Mining Engineer to the Government of Western Australia.

The paper and discussion will be published in a subsequent number of the *Journal*.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be delivered on Wednesday afternoons, January 4th and 11th, at 5 o'clock, by ARTHUR MASON WORTHINGTON, C.B., M.A., F.R.S., Professor of Physics in the Royal Naval Engineering College, Devonport, on "A Study of Splashes, conducted by the aid of Instantaneous Photography."

Each Member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to Members in the order in which applications are received.

Members who desire tickets for the course are requested to apply for them at once.

ROYAL SOCIETY OF ARTS ALBERT MEDAL.

At the request of the Council, Sir Edward Grey, Secretary of State for Foreign Affairs, authorised the transmission of the Society's Albert Medal to His Majesty's Ambassador at Paris for presentation to Madame Curie. Sir Francis Bertie received Madame Curie at the British Embassy on November 25th, and handed to her the Albert Medal, stating that he had been instructed by the Secretary of State to present it to her on the part of the Royal Society of Arts in recognition of the services rendered to the world by her discovery of Radium, and adding that it gave him great pleasure to be the medium of carrying out the wishes of the Society.

PROCEEDINGS OF THE SOCIETY.

THIRD ORDINARY MEETING.

Wednesday, November 30th, 1910; Sir ALEXANDER HENDERSON, Bart., in the chair.

The following candidates were proposed for election as members of the Society:—

Briggs, Miss Irlam, Milnthorpe, Parkstone, Dorset.
Cooper, Alfred Heaton, May Field, Ulverstone, Lancashire.

McDonald, Thomas J., Assoc.M.Inst.C.E., Mansfield, Arrochar, Loch Long, N.B.

Mitchell, Hawthorn, 39, Mecklenburgh-square, W.C.

Murray, Reginald, 12, Bedford-row, W.C.

Power, John Cecil, 1, Queen's-ride, Barnes Common, S.W.

Sotham, Bernard, c/o Messrs. Lynch, Teheran, Persia, and The Priory, Iffley, Oxford.

Stanley, William Neems, 12, Spencer-road, Cottenham Park, Wimbledon, Surrey.

Wheeler, R. Vernon, D.Sc., The Colliery House, Altofts, Yorkshire.

The following candidates were balloted for and duly elected members of the Society :—

Aitken, William, 17, Church-street, Dumbarton, N.B.

Anderson, Rev. James Forrester, B.D., B.Sc., B.A., St. John's Presbyterian Church, Port Louis, Mauritius.

Anderson, Robert, 8, Esplanade East, Calcutta, India.

Andrews, Frank M., Metropolitan Building, New York City, U.S.A.

Archibald, Captain James F. J., 1053, Marbridge Building, Herald-square, New York City, and Army and Navy Club, Washington, D.C., U.S.A.

Arnold, Felix, Ph.D., A.B., 824, St. Nicholas-avenue, New York City, U.S.A.

Arnot, David, c/o Messrs. Wilson, Sons & Co., Rio de Janeiro, Brazil.

Barrow, John, 26, Old Broad-street, E.C.

Bethune, J. T., 406, Eastern Townships Bank Building, Montreal, Canada.

Biswas, Jatindra Kumar, M.A., 23, Crematorium-street, Entally, Calcutta, India.

Blair, David Ker, M.I.Mech.E., 11, Grey-street, Wellington, New Zealand.

Blamires, Joseph, Bradley Lodge, Huddersfield.

Brown, Percy, 28, Chowringhee, Calcutta, India.

Burlton, C. H. B., Highmore-house, Hereford.

Chessum, Roland B., Woodbury, Enfield, N., and 7A, South-place, E.C.

Clifford, Charles, Chudleigh, Halfin-road, Rangoon, Burma.

Clutton, Miss Maria, 5, Chester-place, Regent's-park, N.W.

Davidson, David, Station-house, Galashiels, Scotland.

Day, Miss Ruth M., 15, Taviton-street, W.C.

Deb, Atindra Krishna, 4, Shampuker-lane, Calcutta, India.

Dickinson, H. P., 807, Majestic Building, Denver, Colorado, U.S.A.

Duncan, Professor Robert Kennedy, 4715, Wallingford-street, Pittsburgh, Pennsylvania, U.S.A.

Dunnington, Professor Francis P., University of Virginia, Charlotteville, Virginia, U.S.A.

Fauth, J., Messrs. Zaretzky, Bock and Co.'s Rice Mills, Dawbong, Rangoon, Burma.

Ferguson, James R., Rooms 314-315, Birk's Building, Montreal, Canada.

Fripp, R. MacKay, 429, Pender-street West, Vancouver, British Columbia, Canada.

Gage, Professor Simon Henry, Stimson-hall, Cornell University, Ithaca, New York, U.S.A.

Gajjar, Professor T. K., M.A., B.Sc., F.C.S., Techno-Chemical Laboratory, near Girgaum, Tram Terminus, Bombay, India.

Ganguly, Ananda Lal, Khalia P.O., Faridpur District, East Bengal, India.

Garnham, James Coote, 132, Upper Thames-street, E.C., and Holmleigh, 3, Fountayne-road, Stoke Newington, N.

Garrett, Thomas Richard Henry, M.A., c/o Messrs. G. Gillespie and Co., Rangoon, Burma, and 16, Queensland-road, Boscombe, Hants.

Giangirji, Raja Bahadur Narsingirji, Begum Bazaar, Hyderabad, Deccan, India.

Gilbert-Wood, Clarence, 5 and 3, Arundel-street, Strand, W.C., and Bertwood, Wimbledon, S.W.

Gill, George T. S., 37, Lancaster-road, Hampstead, N.W.

Greenwell, George Harold, c/o Messrs. Kilburn, and Co., 4, Fairlie-place, Calcutta, India.

Gregg, William Henry, M.D., 135, Cambridge-place, Brooklyn, New York, U.S.A.

Hazard, Hon. Rowland Gibson, A.M., Holly-house, Peace Dale, Rhode Island, U.S.A.

Hollingsworth, John Burton Lee, D.V.S., M.D.C., 105, Cambridge-street, Ottawa, Canada.

Horne, Rev. Joseph White, M.A., Ivy-house, High-street, Highgate, N.

Hotson, John Ernest Buttery, I.C.S., Secretariat, Bombay, India.

Huber, E. H., 510, Quincy Building, Denver, Colorado, U.S.A.

Innes, Charles, B.Sc., Assoc.M.Inst.C.E., c/o Messrs. T. Cook and Sons, Rangoon, Burma.

Jacobs, J. Warren, Waynesburg, Pennsylvania, U.S.A.

Katayama, Tokuma, Bureau of Works of the Imperial Household Department, Tokio, Japan.

Keay, Lyle, The Mercantile Bank of India, Calcutta, India.

Knight, Joseph, Southfields, Bury, Lancashire.

Lay, Harry Arthur, 45, Hanley-road, Hornsey-rise, N.

Lee, Professor Edwin, B.S., A.M., M.Sc., Meadville, Penn., U.S.A.

Leggatt, Percy Scott, 15, Marine-parade, Lowestoft.

Levene, Dr. P. A., 230, West 139th Street, New York City, U.S.A.

Lubbock, Hon. John Birkbeck, 15, Lombard-street, E.C.

McBride, James H., M.D., Pasadena, California, U.S.A.

Mead, Marvin Hulst, 382, River-drive, Passaic, New Jersey, U.S.A.

Mitchell, Francis James, Srinagar, Kashmir State, India.

Morris, William Hardwicke Grant, A.M.I.Mech.E., Cairo Water Works, Rod El Farig, Egypt.

Mower, Charles Huson, 147, Queen Victoria-street, E.C., and 14, Lower Berkeley-street, W.

Muthukoya-Thangal, Khan Bahadur P.M., Calicut, India.

Nath, Rai Sahib Dewan Amar, Chief Minister to His Highness the Maharaja, Jammu and Kashmir State, India.

Nichalls, J. Mayne, The Nitrate Railways Co., Ltd., Iquique, Chili, South America.

O'Callaghan, T. P. M., Gauhati, Assam, India.

Peart, Arthur Wellesley, B.A., The Maples, Burlington, Ontario, Canada.

Percy, Norman Crook, Assoc.M.Inst.C.E., Byculla Ironworks, Bombay, India.

Pitt, George Earley, B. ès L., Knutsford, Cadbury-road, Moseley, Worcester.

Poats, Thomas Grayson, Clemson Agricultural College, Clemson College, South Carolina, U.S.A.

Powell, Henry Richard, South Lawn, Bickley, Kent.

Prentice, Thomas Theophilus, Assoc.M.Inst.C.E., Empresa del Agua, Lima, Peru, South America.

Pyne, Herbert Barrington, Assoc.M.Inst.C.E., 370, Calle Cangallo, Buenos Aires, Argentine.

Richards, H. W., Brookside, Beverley-road, Barnes, S.W.

Robinson, James, Assoc.M.Inst.C.E., Bhagalpur, Bengal, India.

Roe, Richard Dartnell Tennant, Assoc.M.Inst.C.E., Sir John Jackson (Chile), Ltd., Ferro Carril Arica La Paz, Arica, Chile, South America.

Rohrer, C. W. G., M.A., M.D., B.Sc., Baltimore, Maryland, U.S.A.

Sahasrabudhe, Rao Sahib Ganesh Nagesh, Ellichpur, Amraoti District, Berar, Central Provinces, India.

Seligmann, Albert, 49, Fitzjohn's-avenue, N.W.

Sharrock, Charles Williams, Dorincourt, Grays, Essex.

Sheoparshad, Rai Bahadur Lala, Rais and Honorary Magistrate, Chandni Chowk, Delhi, India.

Shukul, Rai Bahadur Pundit Bishun Dutta, Sehora-road (E.I. Railway), Jubbulpore District, Central Provinces, India.

Smeaton, Major Charles Oswald, R.A., United Service Club, Pall Mall, S.W.

Smith, William Charles Ernest, M.Inst.C.E., The Nitrate Railways Co., Iquique, Chile, South America.

Spoor, Stanley M., 59, Chancery Lane, W.C.

Stewart, Captain Thomas, V.D., K.I.H., 1, Thackeray-road, Alipore, Calcutta, India.

Stirk-Inglis, F. A., c/o O. H. McCowan, LL.B., Y.M.C.A., Rangoon, Burma.

Stowell, Herbert, 10, Morley-road, Southport.

Taylor, Edward, 17, Thurleigh-road, Wandsworth-common, S.W.

Watkins, Stephen, Assoc.M.Inst.C.E., Ottoman Railway, Smyrna, Turkey in Asia.

Wills, J. Lainson, F.C.S., 133, Midwood-street, Brooklyn, New York, U.S.A.

Woodhouse, Thomas, Briarcliffe, Wormit, near Dundee.

Yearsley, Walter A., Rosador, St. Anne's-on-Sea, Lancashire.

Zizold, Alfredo, Lima, Peru, South America.

The paper read was—

ARGENTINA FROM A BRITISH POINT OF VIEW.

By Campbell P. Ogilvie.

Argentina, which does not profess to be a manufacturing country, exported in 1909 material grown on her own lands to the value of £79,000,000, and imported goods to the extent of £60,000,000. This fact arrests our attention, and forces us to recognise that there is a trade balance of nearly 20 million pounds sterling in her favour, and to realise the saving power of the country.

It is not mere curiosity which prompts us to ask: "Are these £79,000,000 worth of exports of any value to us? Do we consume any of them? Do we manufacture any of them? And do we send any of this same stuff back again after it has been dealt with by our British artisans?" It would be difficult to follow definitely any one article, but upon broad lines the questions are simple and can be easily answered. Amongst the agricultural exports we find wheat, oats, maize, linseed, and flour. The value placed upon these in 1908 amounted to £48,000,000, and England pays for and consumes nearly 42 per cent. of these exports. Other goods, such as frozen beef, chilled beef, mutton, pork, wool, and articles which may be justly grouped as the results of the cattle and sheep industry, amounted to no less a figure than £23,000,000. All these exports represent foodstuffs or other necessities of life, and are consumed by those nations which do not produce enough from their own soil to keep their teeming populations. Another export which is worthy of particular mention comes from the forests, viz., quebracho, which, in the form of logs and extract, was exported in 1908 to the value of £1,200,000. The value of material of all sorts sent from England to Argentina in 1908 was £16,938,872 (this figure includes such things as manufactured woollen goods, leather goods, oils, and paints), therefore it is clear that we have, and must continue to take, a practical and financial

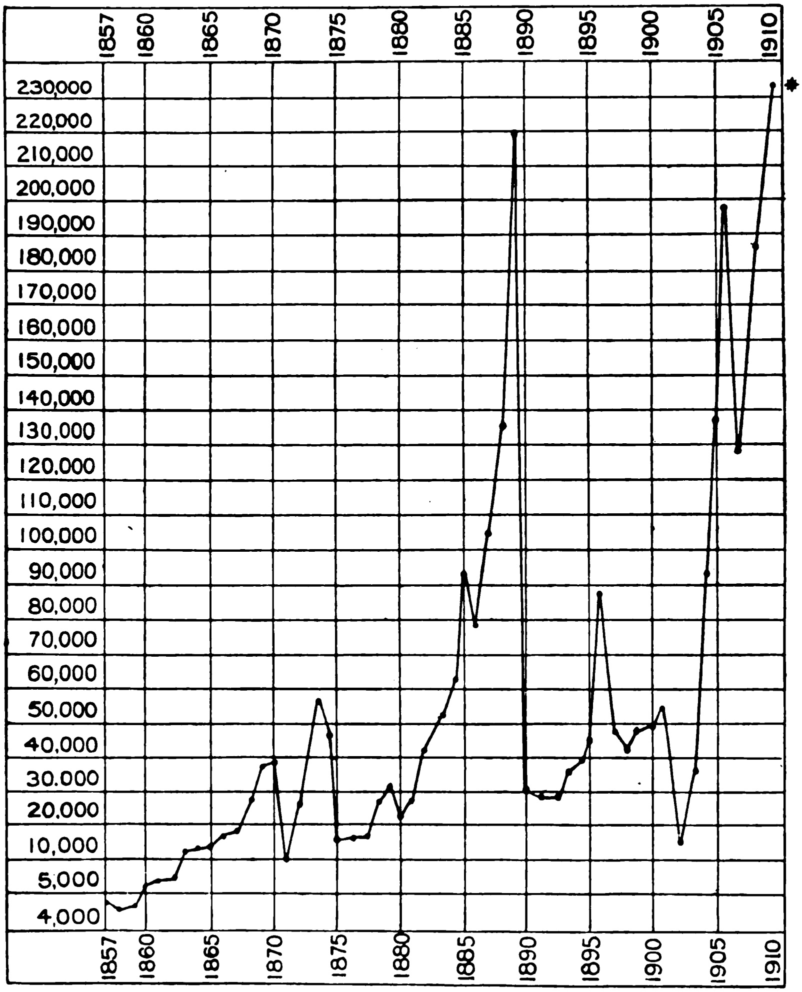
interest in the welfare and prosperity of Argentina.

New countries cannot get on without men willing and ready to exploit Nature's gifts, and, naturally, we look to the immigration returns when considering Argentina's progress. To give each year's return for the last fifty years would be wearisome, but, taking the average figures for ten-year periods from 1860 to 1909, we have the following interesting table (the figures represent the balance of those left in the country after allowing for emigration):—

	Yearly average.
From 1860 to 1869 (inclusive) . .	15,044
„ 1870 „ 1879 „ . .	29,462
„ 1880 „ 1889 „ . .	84,586
„ 1890 „ 1899 „ . .	43,618
„ 1900 „ 1909 „ . .	100,998

TABLE I.

DIAGRAM OF IMMIGRATION RETURNS.



* 231084 IN 1909

NOTE:— IN THE YEARS 1888, 1889 & 1890 THE ARGENTINE GOVERNMENT ASSISTED PASSAGES.

Sixty-five per cent. of the immigrants are agricultural labourers, who soon find work in the country, and again add their quota to the increasing quantity and value of materials to be exported.

Table I. is a diagram of the Immigration Returns from 1857 to 1909.

Nature has been lavish in her gifts to Argentina, and man has taken great advantage of these gifts. My desire now is to show what has been done in the way of developing agriculture in this richly-endowed country during the last fifty years. One name which should never be forgotten in Argentina is that of William Wheelwright, whose entrance into active life in Buenos Aires was not particularly dignified. In 1826 he was shipwrecked at the mouth of the River Plate, and struggled on barefooted, hatless and starving, to the small town of Quilmes.

Mr. Wheelwright was an earnest and far-seeing man, and his knowledge of railways in the United States helped him to realise their great possibilities in Argentina; but, strange to say, upon his return to his native land he could not impress any of those men who afterwards became such great "Railway Kings" in the U.S.A. Failing to obtain capital for Argentine railway development in his own country, Wheelwright came to England, and interested Thomas Brassey, whose name was then a household word amongst railway pioneers. These two men associated themselves with Messrs. Ogilvie and Wythes, forming themselves into the firm of Brassey, Ogilvie, Wythes and Wheelwright, whose first work was the building of a railway 17·480 kilometres long between Buenos Aires and Quilmes in 1863; afterwards they built the line from Rosario to Cordova, which is embodied to-day in the Central Argentine Railway. Other railways were projected, and this policy of progress and extension of the steel road still holds good in Argentina.

The year 1857 saw the first railway built, from Buenos Aires to Flores, 5·879 kilometres long; in 1870 there were 457 miles of railroad; in 1880 the railways had increased their mileage to 1,572; in 1890 Argentina possessed 5,895 miles of railway, and in 1900 there were 10,352 miles.

The rapid increase in railway mileage during the last nine years is as follows:—

In 1901	there	were	10,565	miles	of	railway.
„ 1902	„	„	10,868	„	„	„
„ 1903	„	„	11,500	„	„	„
„ 1904	„	„	12,140	„	„	„
„ 1905	„	„	12,370	„	„	„
„ 1906	„	„	12,850	„	„	„
„ 1907	„	„	13,829	„	„	„
„ 1908	„	„	14,825	„	„	„
„ 1909	„	„	15,937*	„	„	„

* These figures are approximate.

12,000 of these are owned by English companies, representing a capital investment of £170,000,000.

In other words, for the last forty years Argentina has built railways at the rate of over a mile a day, and in 1907, 1908, and 1909 her average rate per day was nearly three miles. This means that, owing to the extension of railways during this last year alone, over a million more acres of land could have been given up to the plough if suitable for the cultivation of corn.

When William Wheelwright first visited Argentina it was little more than an unknown land, whose inhabitants had no ambition, and no desire to acquire wealth—except at the expense of broken heads. There was a standard of wealth, but it lay in the number of cattle owned; land was of little value, save for feeding cattle, and therefore counted for naught, but cattle could be boiled down for tallow; bones and hides were also marketable commodities; the man, therefore, who possessed cattle possessed wealth.

The opening out of the country by railways soon changed the aspect of affairs. The man who possessed cattle was no longer considered the rich man; it was he who owned leagues of land upon which wheat could be grown who became the potentially rich man; he, by cutting up his land and renting it to the immigrants, who were beginning to flock in an endless stream into the country, found that riches were being accumulated for him without much exertion on his part. He took a risk, inasmuch as he received payment in kind only. Therefore, when the immigrants did well, so did he, and, as many thousands of immigrants have become rich, it follows that the land proprietors have become immensely so. It was the railways which created this possibility, and endowed the country by rendering it practicable to grow corn where cattle only existed before, but many Argentines to-day forget what they owe to the railway pioneers; it is the railways, and the railways only, which render the splendid and yearly increasing exports possible.

In 1858 cattle formed 25 per cent. of the total wealth of Argentina, but in 1885 cattle only represented 18 per cent. of the total wealth, railways having made it possible during those thirty years to utilise lands for other purposes than cattle-feeding. Let it be clearly understood, the total value of cattle had not decreased; far from that, the cattle had increased in value during the above period to the extent of

£48,000,000, and to-day cattle, sheep, horses, mules, pigs, goats, and asses represent a value of nearly £130,000,000. The following table shows how great the improvement has been in Argentine animals:—

			Per head.
Cattle in	1885	were valued at an average of	$13*
„	1908	„ „ „	$32
Sheep in	1885	„ „ „	$ 2
„	1908	„ „ „	$ 4
Horses in	1885	„ „ „	$11
„	1908	„ „ „	$25

Notwithstanding these increased valuations per head, and the larger number of animals in the country, the value created by man's labour far outweighs the increased value of mere breeding animals.

Next to the railways the improvements in shipping have helped the development of Argentina; the shipping trade of Buenos Aires has increased at the rate of one million tons per annum for the past few years, and the entries into the port form an interesting and instructive table.

The following statement gives the total tonnage that passed through the port of Buenos Aires from 1880 to 1909, and will more clearly show the increase and advance made in the last thirty years. These figures include both steamers and sailing-vessels, and local as well as foreign trade:—

	Tons.		Tons.
1880 ..	644,750	1895 ..	6,894,834
1881 ..	827,072	1896 ..	6,115,547
1882 ..	995,597	1897 ..	7,365,405
1883 ..	1,207,321	1898 ..	8,051,045
1884 ..	1,782,382	1899 ..	8,741,934
1885 ..	2,200,779	1900 ..	8,047,010
1886 ..	2,408,323	1901 ..	8,661,300
1887 ..	3,369,057	1902 ..	8,902,605
1888 ..	3,396,212	1903 ..	10,269,298
1889 ..	3,804,037	1904 ..	10,424,615
1890 ..	4,507,096	1905 ..	11,467,954
1891 ..	4,546,729	1906 ..	12,448,219
1892 ..	5,475,942	1907 ..	13,335,733
1893 ..	6,177,818	1908 ..	15,465,417
1894 ..	6,686,123	1909 ..	16,993,973

In 1897, out of the total number of steamers that entered Buenos Aires—viz., 901, with a tonnage of 2,342,391—519, with a tonnage of 1,327,571, were British. Taking the year 1909 we find that 2,008 steamers and 137 sailing-vessels entered the port of Buenos Aires from foreign shores with a tonnage of 5,193,542, and 1,978 steamers and 129 sailing-vessels left the port for foreign shores with a tonnage of 5,174,114; out of these, British boats lead with 2,242 steamers and 37 sailing-vessels, or, say, 53½ per cent. of the total. Germany comes next with 456 steamers and two sailing-vessels, or, say, 10¾ per cent. of the total. Italy, with 307 steamers and 67 sailing-vessels, is next, and then France with 264 steamers. The total number of steamers that entered and left the port from local and foreign ports is 13,485, with a tonnage of 14,481,526, and 20,264 sailing-vessels with 2,512,447 tons, which make up the amount of 16,993,973 tons, as shown above.

In the year 1884 the experiment of freezing beef killed in Buenos Aires, and shipping it to Europe was first tried. That was successful, but an immense improvement was made when the process of chilling became the common means by which meat could be exported. The frozen beef trade in Argentina has had a wonderful development; it commenced in 1884, and the export of chilled meat has progressed steadily at the rate of 25,000 beeves yearly, until, in 1908, it reached the enormous quantity of 573,946 beeves, or 180,000 tons. Frozen mutton has remained comparatively steady, and has only increased by 38,000 tons in twenty-two years, or from 2,000,000 sheep frozen in 1886 to 3,297,667 in 1908, whilst "jerked beef," which was mostly sent to Cuba and Brazil, has fallen from 50,000 tons per annum to 6,651 tons. The value of frozen and preserved meats exported in 1908 was £5,233,948.

The value of live-stock in Argentina in 1908 was made up as follows:—

Cattle	£82,000,000
Sheep	25,000,000
Horses	18,000,000
Mules	2,000,000
Pigs	1,368,000
Goats and Asses	1,000,000

A few years ago it was common on an estancia feeding 50,000 or 60,000 cattle to find the household using canned Swiss milk. To-day, 425,000 litres of milk are brought into the city of Buenos Aires each day for consumption, and no less than two tons of butter, one ton of cream, and three tons of cheese are used there daily. Argentina also exports butter. This trade has sprung up entirely within the last fourteen years, and in 1908 she exported 3,549 tons of butter, the value of which was £283,973.

* The dollar referred to throughout this Paper is the Argentine paper dollar which since 1899 has had a fixed value, and is worth approximately 1s. 9d. Previous to that date its value fluctuated considerably.

Until 1876 Argentina imported wheat for home consumption; in that year, when for many years past agricultural labourers had been arriving at an average of 25,000 per annum, she began to export wheat with a modest shipment of 5,000 tons. Thirty years later the export had mounted up to 2,247,988 tons, and in 1908 the wheat exported amounted to 3,636,293 tons, and was valued at £25,768,520. Agricultural colonies had sprung up everywhere, and cattle became of second-rate importance; to-day the value of the exports of corn, which term includes wheat, barley, maize, oats, etc., is more than double that of cattle and cattle products. It is interesting to follow the evolution wrought by labour, intelligence, and capital in the prairie lands of Argentina. First, let us note the developments on those wonderful tracts of splendid prairie lands lying between the River Plate and the Andes; fifty years ago these lands were of little account, and only a few cattle were to be found roaming about them, but upon the advance of the railway they came under the plough, and, without much attention or care, produced wheat and maize. After a time improvements in the method of cultivation produced a better return, and to-day a great deal of attention is paid to the preparing of the land, and thought and care are given to the seed-time, the growing and the harvest. When it is found desirable to rest the land after crops of wheat and maize, etc., alfalfa is grown thereon. Alfalfa is one of the clover tribe, and has the peculiar property of attaching to itself those micro-organisms which are able to fix the nitrogen in the air and render it available for plant food. Every colonist knows the value of alfalfa for feeding his animals, but it is not every colonist who knows why this plant occupies such a high place amongst feeding-stuffs. Alfalfa is easily grown, very strong when established, and, provided its roots can get to water, will go on growing for years. The *raison d'être* for growing alfalfa is for the feeding of cattle and preparing them for market, and for this purpose a league of alfalfa (6,177 acres metric measurement) will carry on an average 3,500 head. When grown for dry fodder it produces three or four crops per annum and a fair yield is from six to eight tons per acre of dry alfalfa for each year. A ton of such hay is worth about $20 to $30, and after deducting expenses there is a clear return of about $14 per acre.

The figures supplied by one large company are interesting; they show that on an average, cattle, when placed upon alfalfa lands, improve in value at the rate of $2.00 per head per month so it is easy to place a value on its feeding properties. Thus we will take a camp under alfalfa capable of carrying 10,000 head of cattle all the year round, where, as the fattened animals are sold off, an equal number is bought to replace them. Such a camp would bring in a clean profit of $200,000 per annum, and the property should be worth £175,000 sterling. An animal that has been kept all its life on rough camp, and, when too old for breeding, is placed for the first time on alfalfa lands, fattens extremely quickly, and the meat is tender and in quality compares favourably with any other beef. No business in Argentina of the same importance has shown such good returns as cattle breeding, and these results have been chiefly brought about by the introduction of alfala, fand a knowledge of the life history of alfalfa is of the greatest importance to the cattle farmer. All cereal crops take from the soil mineral matter and nitrogen. Therefore, after continuous cropping, the land becomes exhausted and generally poorer; experience has taught us that rotation of crops is a necessity to alleviate the strain on the soil, and such an axiom has this become that in many cases English landlords insist that their leases shall contain a clause binding the tenants to grow certain stated crops in rotation.

This system is known in England as the four-course shift. Knowledge gained by successive generations of observant farmers has given us the key to what Nature had hitherto kept to herself, and to-day we know why the plan adopted by our forefathers was right, and why the rotation of crops was, and is, a necessity. Men of science are devoting their lives to the systematic study of Nature's hidden secrets, and by means of agricultural colleges, as well as private individual research, these discoveries are being given to mankind, and long before the soils of Argentina show any serious loss of nitrogen from continuous cropping, science will probably have established means of applying in a practical manner those methods already known of propagating the nitrogen-collecting bacteria which thrive on alfalfa, clover, peas, soya beans, and other leguminous plants. Almost every country is now devoting time, money, and energy to agricultural research work. In 1908 the Agricultural College at Ontario prepared no less than 474 packages of legume bacteria, and in 309 cases beneficial results followed from the application thereof to the soil; in 165 cases no improvements in the crops were noticed. This may, however, have been due to the want of

knowledge of how to manipulate the bacteria, or to lack of experience in noting effects scientifically, but in any case the experiment must be considered successful when the results obtained were satisfactory in no less than 65 per cent. of the trials. No greater factor exists than the microscope in opening up and hunting out the secrets concealed in the very soil we are standing on.

If soils were composed of nothing but pure silica sand, nothing would ever grow; but in Nature we find that soils contain all sorts of mineral matter, and chief amongst these is lime.

Alfalfa thrives on land which contains lime, and gives but poor results where this ingredient is deficient. The explanation is simple. There is a community of interest between the very low microscopic animal life, known as bacteria, and plant life generally. In every ounce of soil there are millions of these living germs which have their allotted work to do, and they thrive best in soils containing lime.

If one digs up with great care a root of alfalfa (it need not be an old plant, the youngest plant will show the same peculiarity), and care is taken in exposing the root (perhaps the best method is the washing away of the surrounding earth by water), some small nodules attached to the fine, hair-like roots are easily distinguished by the naked eye, and these nodules are the home of a teeming, microscopical, industrious population, who perform their allotted work with the silent, persistent energy so often displayed in Nature. Men of science have been able to identify at least three classes of these bacteria, and to ascertain the work accomplished by each. The reason for their existence would seem to be that one class is able to convert the nitrogen in the air into ammonia, whilst others work it into nitrite, and the third class so manipulate it as to form a nitrate which is capable of being used for plant food.

Now, although one ton of alfalfa removes from the soil 50 lbs. of nitrogen, yet that crop leaves the soil richer in nitrogen, because the alfalfa has encouraged the multiplication of those factories which convert some of the thousands of tons of nitrogen floating above the earth into substance suitable for food for plant life. As a dry fodder for cattle three tons of alfalfa contain as much nutrition as two tons of wheat.

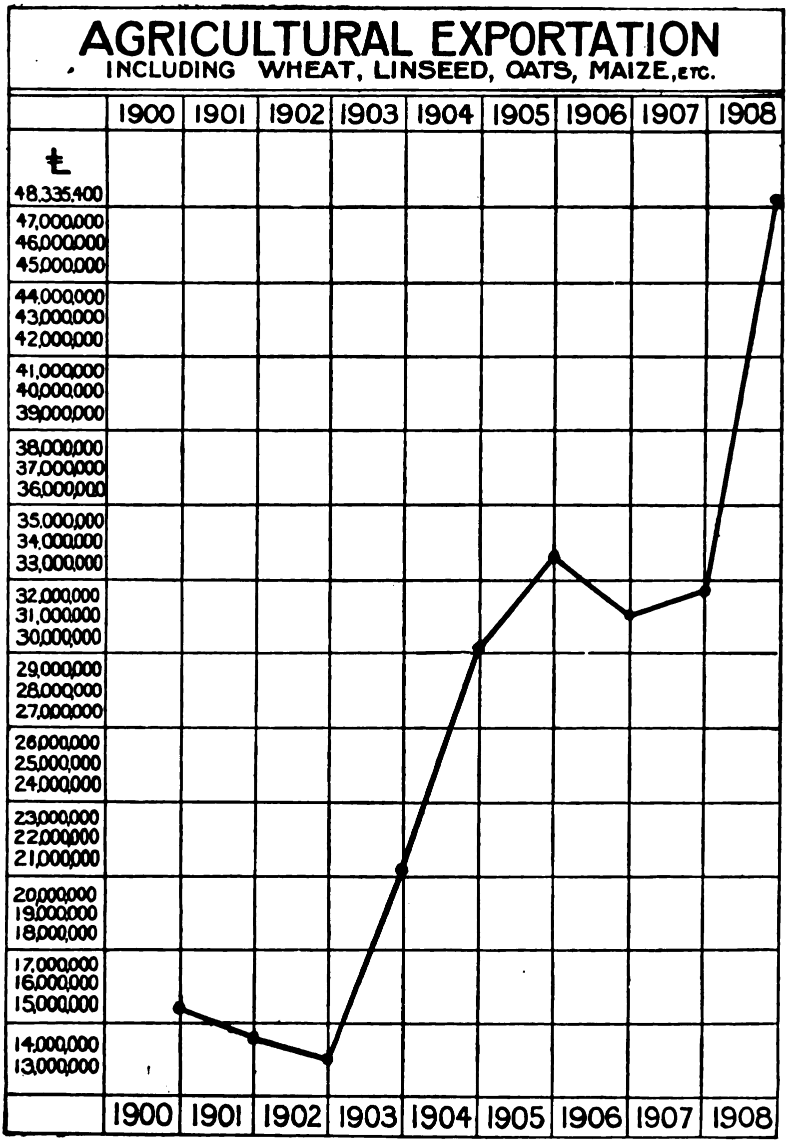
The cost of growing alfalfa greatly depends upon the situation of the land to be dealt with; also upon whether labour is plentiful or not; but, in order to give some idea of the advantage of growing this cattle food, we will imagine the intrinsic value of the undeveloped land to be £4,000, upon which, under existing conditions, it would be possible to keep 1,000 head of animals, whereas if this same land were under alfalfa, 3,000 to 3,500 animals would be fattened thereon, and the land would have increased in value to £20,000 or £30,000.

Now, if the undeveloped land is to be improved, it becomes necessary either to work it yourself, with your own men, in which case you must provide ploughs, horses, bullocks, etc., or to carry out the plan usually adopted, that of letting the land to colonists who have had some experience in this class of work. Usually a colonist will undertake to cultivate from 500 to 600 acres, and agrees to pay to the landowner anything from 10 per cent. to 30 per cent. of his crops, according to the distance of the land from the railway. The colonist brings his agricultural tackle along with him, and establishes his house (usually a most primitive affair), digs his well, and then proceeds to plough. In this work the whole family joins; the father leads the way, followed by the eldest child, and all the others in rotation, with the wife bringing up the rear; she keeps a maternal eye upon the little mite, who with great gusto and terrific yells manages somehow to cling to the plough and to do his or her share with the rest. Is it to be wondered at that work progresses fast under these conditions? There is but one idea prevalent in the family—namely, that time and opportunity are with them.

The first crop grown on newly-broken ground is usually maize; the second year's crop is linseed, and perhaps a third year's crop—probably wheat—is grown by the colonist before the land is handed back to the owner ready to be put down in alfalfa. The colonist's cultivation of the land will have effectually killed off the natural rough grasses which would otherwise grow up and choke the alfalfa. Sometimes the alfalfa is sown with the colonist's last crop, and in such cases the landowner finds the alfalfa seed, and during the sowing of this crop it is very advisable that either he or his agent should be in constant attendance, because the after-results greatly depend upon the care with which the seeding has been done. When the colonist's contract is completed he moves on to another part, and the owner, who has year by year received a percentage of the crops, takes back his land. Considerable outlay has now to be made in fences, wells, and buildings; the more there are of these the better, the land will carry a larger head of cattle, and the control of them is easy when the camp has been properly divided.

The colonists are generally Italians. They are an industrious and kindly people, hardy and quiet, well content with their surroundings, careful and frugal in their living, and many thousands could go back to their own country

TABLE II.



with wealth which has been acquired by constant and assiduous attention to the economies of life.

It has often been said that an Englishman will starve where an Italian will thrive, and in some respects this is true; but it would be better expressed if it were stated that an Italian can adapt himself to circumstances better than an Englishman. At the same time I doubt if an Italian would come off best were the two placed on a desert island where instantaneous action, grit, and endurance were called for.

Many things are said of an Englishman, and none fits his character better than that which gives him the privilege of "grumbling," and this characteristic becomes more marked when he is able to grumble with one of his own kith and kin. I have heard Argentines praise Englishmen —who, they say, manage their estancias far and away beyond all others—but at the same time they have told me that they would never allow two Englishmen on their place at once.

It has been said that many of the immigrants do not intend to settle in the country. Probably this idea has gained ground on account of the large numbers of the labouring population, who are attracted to Argentina by the high wages ruling during the harvest time, and then find it pays them to go home and secure the European harvest, but generally these men come out again to stay. They have acquired a knowledge of the country, and often enough have also acquired an interest in some land, and they return, bringing their families, to adopt Argentina as their home for a period at least.

A glance at the statistics prepared by the authorities in Buenos Aires shows that during the last fifty-two years 4,250,980 persons entered as immigrants, and out of this number only 1,690,783 returned, leaving in the country 2,560,197 individuals, or an average of 50,000 workers per annum. These figures have become even more marked of recent years. Taking the last five years, the country has received on an average 249,000 immigrants per annum; of these, 103,000 went back. In other words, 727,670 have made their homes within the borders of Argentina during the past five years, and of these at least 500,000 were agriculturists.

It is not to be wondered at, then, that the exports, chiefly made up of agricultural produce, have shown extraordinary progress. Table II. is a diagram showing the agricultural exportation from 1900 to 1908.

Nothing can be more eloquent than the figures shown in Table II. This remarkable progress, almost steady in its upward march, is not in one direction only. Argentina is an ideal country for agriculturists, and in every branch of that industry progress has been made. Greater care is being taken to-day in working up the by-products of the cattle business. More varied crops are being grown, and vegetable by-products are being economically looked after. The forests of Argentina are also being worked for the benefit of mankind. The quebracho colorado tree forms a very important item of export. It is sent out of the country either in the form of logs, of which no less than 254,571 tons were exported in 1908, or in the form of an extract for tanning purposes; 48,162 tons of this extract were made and exported in 1908, and a small quantity of the wood was exported in the shape of sawdust. The total value of quebracho colorado exported in various forms in that year was, as already stated, £1,200,000. This means that the quebracho forests are being depleted at the rate of half a million tons per annum for export purposes alone, in addition to the enormous quantities used for sleepers, etc., in the country.

The area in acres under cultivation for the year 1908 was 46,174,250, an increase of 265 per cent. on the land under cultivation in the year 1895.

Table III. shows the area in hectares cultivated from 1897 to 1908.

Wheat.—The area under cultivation for wheat shows an increase of 89 per cent. in ten years from—

8,000,000 acres in cultivation in 1898, to
15,157,750 „ „ „ „ 1908

Linseed shows an increase of 361 per cent. from—

831,972 acres in cultivation in 1898, to
3,835,750 „ „ „ „ 1908

Maize increased by 250 per cent., and other crops, including oats, 300 per cent. in the same period.

The United Kingdom purchased from Argentina and retained for its own use (in round figures) during the year 1908—

Wheat . . .	to the value of	£13,000,000
Maize . . .	„ „	5,600,000
Frozen Meat .	„ „	9,300,000
	Making a total of	£27,900,000

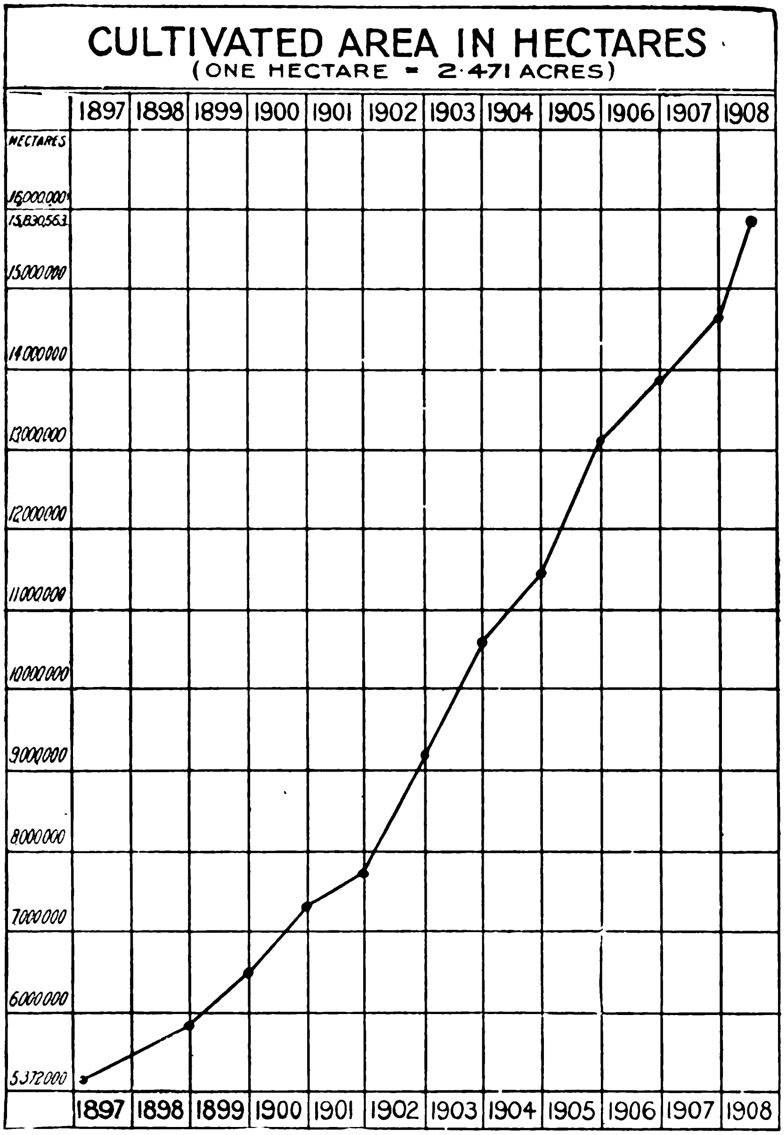
Indeed, we buy from Argentina nearly 25 per cent. of our total food purchased abroad, and she supplies nearly 29 per cent. of our corn and grain requirements. These figures again clearly demonstrate that we have a vital interest in the well-being of our friends across the sea.

In every direction Argentina has progressed, and judging from the past we may look with confidence to the future; the total area of the Republic is 776,064,000 acres, and certainly it is within the bounds of reasonable forecast to consider that 100,000,000 acres of this land will be, when opened up by railways, and other facilities, available for corn growing. To-day only one-fifth of this available area is being cultivated, and another 43,000,000 acres are being utilised for feeding purposes; thus only 63,000,000 out of 776,000,000 acres are being occupied. The chief reason why more is not utilised is because there is not sufficient labour available.

	Inhabitants per square mile.
Argentina	has 5
Russia	„ 18
Canada, Newfoundland, etc. . . .	„ $1\frac{1}{2}$
Australia	„ $1\frac{1}{3}$
United Kingdom	„ 364
Belgium	„ 625
Germany	„ 290

Not only is there an enormous tract of land lying dormant, but the productive power of land now under cultivation may be vastly increased if farmers will devote their attention to improving the conditions of cultivation. 11·3 bushels of wheat per acre is not high-class farming, yet this is the average production for Argentina. Manitoba in 1908 produced 13½ bushels per acre, Saskatchewan, 17 bushels. In the fourteenth century England only produced 10 bushels per acre, but we have improved this yield to 30 bushels, while Roumania has increased her yield from 15 bushels per acre in 1890, to 23 bushels in 1908. France has increased her yield from 17 bushels in 1884, to 20 bushels in 1908. Germany has increased her yield per acre from 20 bushels in 1899, to 30 bushels in 1908. So that we may not only look forward to a greater area being placed under cultivation,

TABLE III.



but we may reasonably expect heavier crops, if land proprietors will bring science to bear on their work of development. Indeed, with land rising in price, with an increasing influx of immigrants and with more intelligent cultivation of the soil, the land must of necessity give a far larger yield than it has done heretofore.

The following tables, taken from the Board of Trade returns, show from whence England draws some of her supplies. They also show how prominently Argentina figures as a food producer. The first table includes corn and meat; the second gives corn alone, and the third meat alone :—

FOOD IMPORTED INTO AND RETAINED BY THE UNITED KINGDOM IN 1908.

Corn (including wheat, barley, oats, rye, buckwheat, peas, beans, maize, wheat-meal, flour, oatmeal, and offals	£71,103,487
Meat, fresh and frozen (including animals for food)	48,704,613
Total	£119,808,100

Of this—			Per cent.
Argentina supplied	£29,569,773	or	24·68
U.S.A. „	38,229,135	„	31·90
Russia „	7,394,607	„	6·18
Canada „	11,907,203	„	9·94
Australia (including Tasmania) supplied	4,520,244	„	3·77
Other Colonies and Foreign Countries supplied	28,187,138	„	23·53
	£119,808,100	„	100·00

Meat, including animals for food, and fresh, chilled frozen and tinned, imported into and retained by the United Kingdom in 1908 :—

			Per cent.
Argentina supplied	£9,285,545	or	19·07
U.S.A. „	18,705,548	„	38·41
Russia „	76,981	„	0·16
Canada „	4,084,113	„	8·38
Australia, including Tasmania, supplied	1,995,471	„	4·10
Other Colonies and Foreign Countries supplied*	14,556,955	„	29·88
	£48,704,613		100·00

* *The other Colonies and Foreign Countries* which largely contributed to the totals mentioned are as follows :—

Denmark—	
Barley	£22,708
Meat	£5,988,573
Roumania—	
Corn, etc.	£2,564,538
Meat	Nil.
Turkey (*including Crete*)—	
Corn, etc.	£1,383,971
Meat	Nil.
Turkey, Asiatic—	
Corn, etc.	£1,344,322
Meat	Nil.
Chili—	
Corn, etc.	£1,099,660
Meat	£10,682
British India—	
Corn, etc.	£2,226,668
Meat	Nil.
New Zealand—	
Corn, etc.	£30,585
Meat	£4,168,649

The lesson shown here is one worthy of attention. We see that Argentina supplies England with one-fourth of her imported food, and U.S.A. supplies nearly one-third. Therefore it behoves both England and Argentina to see that America does not so manipulate things that she acquires the control over our meat and food supplies.

Argentine authorities should not only exercise the law sanctioned February 4th, 1907, concerning the inspection of factories, but they should enforce greater care in seeing that all Argentine saladeros and packing-houses are manipulated with intense care, and cleanliness should be insisted upon; it would be a bad day for Argentina should ever such an outcry be raised against her saladeros as that which a few years ago was directed against the North American packing-houses and for a time ruined the canning industry of the United States, and yet we find American methods being introduced into Argentina without let or hindrance. If our soldiers and sailors are to be fed upon canned meats, let those who are responsible for purchasing the food at least see that it is prepared under healthy and sanitary conditions.

The corn-growing industry of the Argentine Republic is an intensely interesting subject. Before railways and steamships brought the foreign producer into close competition with our own farmers, Argentina did not produce enough grain to supply her home consumption, and cattle were bred only for their hides, tallow and bones. In the course of time, when steamers superseded sailing ships and the world's carrying capacity thus became enormously increased, Argentina saw her opportunity of becoming a keen competitor in the food market. Corn-growing became a highly remunerative business, although much still remains to be learned con-

CORN IMPORTED INTO AND RETAINED BY THE UNITED KINGDOM IN 1908.

	Argentina.	U.S.A.	Russia.	Canada.	Australia (including Tasmania).	Other Colonies and Foreign Countries.	TOTAL.
	£	£	£	£	£		
Wheat	13,096,812	10,779,221	2,286,180	6,335,329	2,402,988	£13,630,183*	£71,103,487
Barley	22,943	733,446	2,622,005	205,697	...		
Oats	1,463,368	...	1,144,387	6,441	...		
Rye	...	129,691	93,066	49,009	...		
Buckwheat	...	...	6,677	...	...		
Peas	...	38,545	42,279	105,495	2,345		
Beans (not fresh, other than Haricot Beans)	...	...	15,094	...	...		
Maize	5,603,463	2,023,576	1,107,858	44,822	...		
Wheatmeal and Flour	50,597	5,407,119	80	809,479	119,440		
Oatmeal and Rolled Oats	...	183,334	...	207,516	...		
Farinaceous substances (except Starch, Farina, Dextrine, and Potato Flour)	...	99,112	...	59,302	...		
Bran and Pollard	11,932	...	...	...	...		
Sharps and Middlings	35,113	...	...	...	...		
Maize Meal	...	129,543	...	...	...		
	20,284,228	19,523,587	7,317,626	7,823,090	2,524,773	13,630,183	71,103,487
Percentage	28·53%	27·46%	10·29%	11·00%	3·56%	19·16%	=100%

* A list of the other Colonies and Foreign Countries which largely contributed to this total will be found on p. 52.

cerning the handling of wheat. Both in the States and Canada grain is handled in a cheaper and more expeditious manner than in Argentina. An enormous amount of grain is dealt with in the Wheat Exchange of Winnipeg, but a further big impetus will be given to this industry when the wheat-fields of Alberta, Saskatchewan, and Manitoba are connected with a deep-sea port on Hudson Bay; this will be an accomplished fact in 1915, and as this route means a thousand miles less haulage by land, and eight hundred less by sea to the chief European ports than by any existing route, it is bound to become the popular one; the chief factor, however, in making it a useful wheat outlet is the established fact that Hudson Bay, although many miles north of Lake Superior, remains free from ice for a period of one month after Lake Superior is tightly frozen up.

Argentina may look forward to keen competition with Canada and Siberia for many years to come; on the other hand, the U.S.A. will steadily show a smaller quantity of wheat available for exportation. The following table throws some light upon the wheat position:—

Argentina and Uruguay have increased the area of their wheat-growing land brought under the plough in the last ten years by	124	per cent.
Canada in the last ten years by	120	,, ,,
Russia ,, ,, ,,	27	,, ,,
United States ,, ,,	14	,, ,,

No country in the world has shown such wonderful capabilities for growing linseed as the Argentine, and her average production for the following five-year periods show this expansion:—

Years.	Production in Tons.
1894-1898	193,000
1899-1903	382,000
1904-1908	839,000

In ten years she increased her production by 335 per cent. In the same period India increased her production by 3·8 per cent., and North America by 105 per cent., whilst Russia was unable to keep up her supply.

The world's total linseed production for 1908 was made up as follows:—

Argentina produced . .	1,101,000	tons.
North America ,, . .	694,000	,,
Russia ,, . .	470,000	,,
India ,, . .	360,000	,,

Here again we find Argentina leading. Moreover, she exported nearly the whole of her production, whilst North America, Russia, and India exported less than half a million tons between them.

It is more than probable that by 1920 Argentina will be able to export, as the result of agricultural work, more than £100,000,000 worth of produce per annum. It is interesting to note that, as the present figures reveal, allowing for a population of 6,500,000 and an agricultural produce export of £48,335,432, each individual in Argentina has sent abroad, after producing enough from the land to keep himself, goods to the value of nearly £8.

Table IV. shows what has been accomplished by Argentina in the last ten years.

In actual money value the exportation of wheat, linseed, oats, maize, other grain, flour, bran, and middlings is, in round figures, as follows:—

1900	£15,485,000	1905	£34,047,000
1901	14,319,000	1906	31,530,000
1902	13,634,000	1907	32,818,000
1903	21,050,000	1908	48,335,000
1904	30,065,000	1909	46,100,000

CATTLE.

The value derived from the cattle industry and its allied produce is of great importance to the Argentine Republic. The exports from this industry may be divided into four heads, namely:—

Live Animals;
Raw Products;
Manufactured; or
Partly Manufactured Material and By-Products.

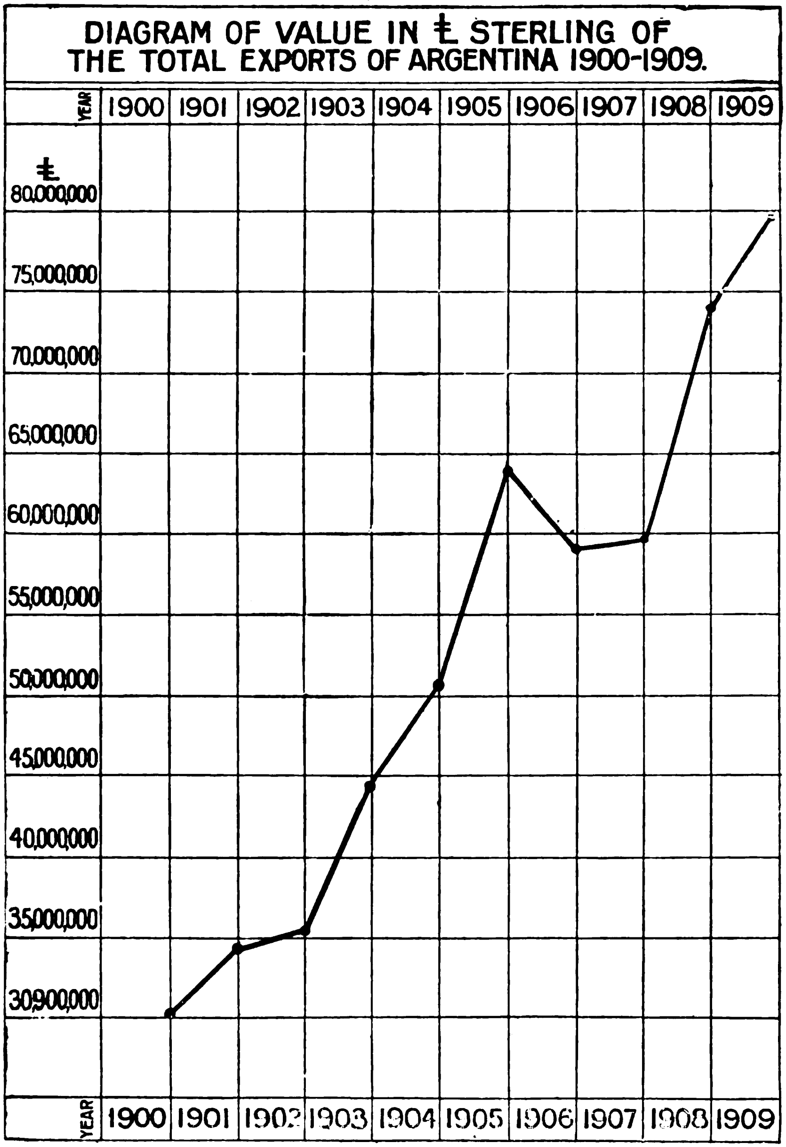
Since the closing of English ports in 1901 to the importation of live cattle from Argentina, the trade in the export of live-stock has fallen off considerably; the total value did not in 1908 amount to more than £568,966; Belgium took 65,224 sheep, Chili took 45,114 cattle and 14,394 sheep, Bolivia took 3,383 head of cattle and 10,676 sheep, and 16,000 asses and mules, while horses were imported into England, Africa, Portugal, Brazil, Uruguay, Chili, Bolivia, and Paraguay.

Exports of raw products, which include frozen and chilled beef and mutton, hides, sheepskins, wool, and such things as horsehair, tallow, jerked beef, etc., represented a value of £19,549,231 in 1908.

Manufactured or partly manufactured material, including prepared tallow, meat extracts, meat, butter, cheese, lard, dressed leather, etc., represented £2,454,760, whilst the by-products, including bones, dried blood, guano, waste fats,

etc., were valued at £430,734. Thus Argentina's total export from the cattle industry (after supplying her own needs) was over £23,000,000.

TABLE IV.



Argentina's live-stock on hand when the last census was taken in May, 1908, was as follows:—

Cattle	29,116,625
Sheep	67,211,758
Horses	7,531,376
Mules, swine, goats, and asses .	6,098,802

representing in value £129,369,628.

The favourite breed of cattle is the Shorthorn, and they comprise 84 per cent. of the classified breeding cows; the Herefords only figure out as 6 per cent., but, undoubtedly, a more careful and complete classification will lead to modifications in these figures, for at the present time no less than five and a half million cows are returned as Criollo cattle—in other words, unimproved stock.

Not until the year 1885, when it became possible to send frozen meat to Europe, did estancieros pay serious attention to growing cattle for meat production, and now, with an ever-increasing quantity of land being placed under alfalfa, the Argentine Republic is fast becoming

the leading factor in the production of meat to satisfy the world's consumption.

Cattle on the outside fringe of occupied lands are still very coarse and rough, with a distinct strain of the Hereford about them; they are, however, a useful herd and most suitable for the districts they occupy, where they often have to undergo the hardships of shortage of pasture owing to drought, and little or no water. Indeed, it is a marvel how these animals exist at times; and assuredly no refined breed of cattle could live where the Criollos not only manage to thrive but generally to return a satisfactory result to their owners. The cattle on ranches which are nearer to the seaports, manufacturing centres, or railway stations, show distinct improvements. Greater care is bestowed upon them, and the main consideration is never lost sight of—it is the ambition of every estanciero to have his cattle graded up so that they are looked upon as "freezers," which means that they are good enough to be purchased by one or other of the refrigerating companies, who take nothing but the best.

In 1888 cattle running the northern camps (which then represented the extreme outlying posts) were only valued at $6 per head.

In 1890 the value had risen to $10 per head.
„ 1900 „ „ „ 15 „
„ 1908 „ „ „ 28 „
„ 1910 „ „ „ 40 „

The question of stock-raising and the object to be obtained must rest with the owners; they must decide whether the land is to be utilised for fattening cattle or for breeding the high-class animals for which there is an ever-ready market. To show the enormous value of animals and the high standard to which agricultural lands can be brought, mention must be made of two estancias near Buenos Aires—viz., those belonging to Messrs. Cobo and Messrs. Bell, where splendid stock is always to be found. To give some idea of the high price paid for first-class pedigree animals, it may be mentioned that £3,800 was paid for a prize Durham bull which was sold to Argentina!

At the cattle show at Buenos Aires held in July, 1910, Herefords for killing realised from £850 to £1,000 per animal! These latter high prices were, however, evidently paid by the agents of cold storage companies for advertising purposes. One representative explained that the freezing companies desired to encourage breeders, and that his company paid the high prices mentioned above so as to let the breeders know that they would always be paid high prices for first-class cattle.

When we consider the really important position which Argentina takes as a food producer, it appears incredible that the English nation (business men and the general public alike) is so extremely ignorant, as a rule, of prevailing conditions. I do not refer to those who have invested their money in the many channels known to the River Plate circle. But men holding high official positions speak of our commercial interests in Argentina as "something between a hundred and a hundred and fifty millions," and then in a whispered side-speech indicate the dangers of revolution.

Often it is suggested that the chances of death from small-pox, yellow fever, and even from murder, are a serious drawback to what might otherwise be a country possible to live in. It makes one very indignant to hear these statements from the lips of those who probably have never left their own country. Let me assure you they may be swept aside, and were it not for their frequent reiteration it would be unnecessary to say that there is not one grain of truth in these suggestions as applied to the state of things to-day.

Nearly one-fifth of the population of Argentina is centred in and around Buenos Aires. It is a city of 1,200,000 inhabitants, many of whom are millionaires, but at the same time there exists much poverty within its precincts; poverty caused in no small degree by the viciousness of the rich, but to a far greater extent by the rooted objection of certain classes to go out to the camps where, during the harvest time at least, wages are high and labour is anxiously awaited.

When we compare the health of this city of Buenos Aires with that of other large cities, we can see what has been done in the way of improvements in the last few years. A glance at the following tables will give some idea of what has been accomplished. The natural increase of the population of Buenos Aires between 1898 and 1907 was 19·1 per 1,000, and no other city equals this.

		Per 1,000 Inhabitants.
The increase in London	. . . . was	8·8
„ „ Berlin	. . . . „	8·5
„ „ New York	. . . „	5·7
„ „ St. Petersburg	. . „	4·6

The birth-rate of Buenos Aires for	1908 was	34·3
„ „ London „	„	25·7
„ „ Berlin „	„	23·3
„ „ New York „	„	28·5
„ „ St. Petersburg	„	27·5

Both these tables are, however, probably affected by the great number of immigrants finding their way to Argentina, many of whom remain in Buenos Aires.

The health of the city may be well gauged by the death-rate for the year 1907.

	Per 1,000 inhabitants.
Buenos Aires stands well with . .	15·2
London has a death-rate of . . .	15·1
Berlin ,, ,, . . .	14·8
New York ,, ,, . . .	18·6
St. Petersburg ,, . . .	25·7

(Undoubtedly the high rate shown by the last-named city is greatly due to the foul condition of the Neva.)

To appreciate thoroughly the position which Buenos Aires now holds, and the strides which have been made in regard to the sanitation of the city, we have but to look at the past. Between the years 1889 and 1898 the death-rate per thousand was as high as 22·9 per 1,000; from 1899 to 1908 it was only 16·6, and now the record stands at 15·2 per 1,000.

The authorities are justly proud of what has been done, and will not diminish their efforts so long as there is work to do and problems to solve.

I should like to state once more the fact that the United Kingdom depends upon Argentina for nearly one-fourth of her food supply purchased abroad. I want to impress upon your minds the seriousness of the position, for this proportion of one-fourth will be largely increased in the near future, for reasons already stated.

The question has often been asked, "Is it safe to buy land in Argentina?" But the drift of this query too often is merely self-interest; in other words, it really means "Can I successfully speculate in land?" Clearly the matter is solely a personal one, no other consideration is thought of, so one is tempted to give an evasive answer. Should the questioner, however, be a young fellow, with God's gift of health and plenty of truth and grit in him, who wants not only to acquire the land, but to work it, then, indeed, there is but one answer, and that is in the affirmative—let him go, and let him ever remember that he is an Englishman and that England is judged by the conduct of her sons, but do not let him make the great mistake a newcomer so often falls into, which is, that because he is an Englishman all other nationalities must be inferior, and that by some sort of divine right he has been created lord of all. Let him realise that those whom he meets in Argentina are as noble and pure as those he left at home. Argentina offers to-day a splendid opening for the best of England's sons, but she does not want the loafer or the ne'er-do-well. Can it be wondered at that England's prestige is seriously injured when so many of the "wasters" and worse are sent from the country? It is but natural that from these who go to foreign countries, England is judged. To my mind, we should send abroad men who are bound to succeed, men who never forget that from their behaviour the Mother Country will be appraised. Argentina will embrace and reward them, but she will spurn and despise the dissolute and drunken.

The advice I would give to all those thinking of trying Argentina as a field for agricultural work is to remember that to be successful one must begin at the bottom: the harder the school the better will be the result: you cannot detect and correct the faults which militate against success unless you have been through the mill. Not long ago I sent a boy out to Argentina and painted the first two years of learning in the new country in rather lurid colours. I explained and dwelt on the hardships—indeed, I described it as "a dog's life." Within a year, the lad wrote home to his parents and mentioned all that I had told him, but finished up by saying, "There's plenty of 'life' about it, but not much 'dog.'" The truth is, that the boy had accepted things as they came along, and had adapted himself to his surroundings, and, I predict, he will never regret having left his home, where opportunities were cramped by small surroundings, for the wider field of Argentina.

A great many Englishmen resident in Argentina, whose sons are looking forward to finding their life's work in that country, send their boys home to England to be educated: far be it from me to deprecate the training acquired by English public-school life, but it might well be worth while to consider the other phase. The boy who has had his schooling in Argentina and goes through his training and passes into one of the local universities will have to his credit something which cannot be bought by money or influence by boys straight out from home. He will have been a fellow-student, and worked shoulder to shoulder with men who will in due time occupy positions of power and influence, and it is just as well to weigh out these things before deciding where to educate your boy. A boy born in Argentina, whatever the nationality of his parents may be, is by Argentine law an Argentine subject, and should be brought up to appreciate that he is liable to be called upon to

go through a military course: the Argentine boy, who has had just as gentle an upbringing as the English boy, is compelled to serve his time in the army if called upon, and generally the discipline engendered by this training has not only been good for him, but is a distinctly valuable asset to the country, and the English boy, as well as a boy of any other parentage born in the country, will be obliged to go through this military training if required.

I venture to think that were England to adopt compulsory military service in some shape or form, we should hear a great deal less of the unemployed and "don't-want-work" demonstrations.

To attempt to give a picture of Argentine life is impossible in the short time at my disposal. Imagine to yourself, if you can, a country of 1,212,600 square miles, whose borders extend from well within the tropics to away down south to the everlasting snows, embracing all kinds of lands, from the very richest of soils to ice-capped and rocky peaks, and you must admit that to attempt to describe the various conditions of life therein is well-nigh impossible. Life is much what the surrounding conditions make it—on the extreme edge of cultivation it is distinctly rough, on the inner camps refinement steps in, and in the cities you will find just what society you wish. Amongst the cosmopolitan population of Buenos Aires there are many men and women of the highest culture and education.

There are many Argentines, standing out prominently from the throng of busy pleasure-seekers, who are devoting their lives to improving the surroundings of those less fortunate fellow-creatures who have fallen upon the thorny path, and whose portion is often the cup of bitterness. Indeed, I have ever found the Argentine desirous of helping those who seek advice and assistance, but he spurns the foreigner who degrades himself and his country by acts of folly which would not be permitted in his native land.

Englishmen often fall into the great error of keeping themselves to themselves. Possibly this trait is engendered from birth and training by our insular position, but it is a great pity to carry it too far, for the Argentine people do appreciate the thoroughness of our countrymen, and are ready to welcome the right sort. We have taught the Argentines many of our national sports and games, and they have entered into them with such thoroughness that the teachers have often had to admit that the pupil has proved better than the master.

Travelling has become an integral part of the education of the Argentine family to-day, and it is quite general to find young children speaking fluently four or five languages.

I could wish that those who have Argentine friends would insist upon their seeing, when in this country, some of the Englishman's home surroundings; for hotel life, theatres, dinners, and music-halls are all very well in their way, but to see the real inwardness of English life you must follow the Englishman to his country home. My experience is that the Argentine will always refuse an invitation to your home at first, because of the trouble which he believes you will be put to, but don't take "no" for an answer; simply make him come, and he will thank you afterwards for his experience of English home life.

Just a word or two, for fear I have left an impression that Argentina is the El Dorado which lies beyond the seas. There are such things as locusts, floods, droughts, and frosts in that country.

The first of these—locusts—are indeed a plague which to-day it seems almost impossible to annihilate, for I have little faith in man's attempts effectually to stop or decrease this pestilence; on the other hand, Nature always seems to be on the alert to prevent an overthrow of the balance of things; those who have spent their lives in the River Plate district have seen this appalling plague crushed by means which Nature, in her own good time, has thought fit to use.

With regard to floods and droughts, these can, at least, be modified by men, and means are now being adopted to conserve the floods and render their waters available in time of drought.

From frosts we seem powerless to defend ourselves, and it is only those whose work is in close touch with the growing and handling of crops who can fully appreciate the damage done by late frosts.

No country is free from drawbacks of some sort or another, and these troubles which I have just mentioned will not prevent the forward march of progress in Argentina.

The Chairman, in proposing a hearty vote of thanks to the author for his interesting and instructive paper, and the series of remarkable cinematograph and lantern-slides with which it had been illustrated, said he had had business relations with Argentina for a number of years, but unfortunately, like many other Englishmen who had relations with the country, he had never had an opportunity of paying a visit to the River Plate. The author was very desirous of bringing before the British public the fact that in the Argentine there was an almost illimit-

able field for British enterprise. At the present time some hundreds of millions of British capital were invested in the Republic, and it seemed probable that that amount would be doubled in the course of a very short period. During the last ten years the developments of the River Plate had been upon a colossal scale. He had recently read "The Life of Sir Woodbine Parish," a book which dealt with the early period of settlement in Argentina, going back to the beginning of the last century; and it seemed almost impossible to imagine that the country there described could be the same as that with which the author had dealt in his Paper. One hundred years had made a marvellous difference in the country, its growth in the last ten years being altogether extraordinary.

The resolution of thanks having been unanimously carried, the meeting terminated.

COTTON-GROWING IN FRENCH COLONIES.

The French Colonial Cotton Association is meeting with much encouragement in its efforts for the cultivation of cotton in Senegal, Upper Senegal, and Dahomey. As yet the output o cotton in these colonies is not large, but the work of experimentation has been in progress only seven years. The area under cultivation and the yield have increased with each season, as the Association gradually extends its work and the natives become more and more familiar with the methods of preparing the soil and harvesting. In 1908 the crop was 780 bales, while in 1909 it increased to 1,085 bales. In some of the French colonies irrigation is necessary, especially in Senegal, and possibly in Algeria, but in the rest of those vast African regions controlled by the French and British Governments the rainfall is sufficient. With so much money being expended under the direction of experienced agents, and with an abundant supply of native labour, the predictions of those interested in the work appear reasonable, and it seems probable that in the course of time Africa will produce, outside of Egypt, several million bales of cotton each year. In the French Cotton Association's report it is stated that in 1909 the Association began the installation and equipment of two ginning plants, one at Noumea and the other at Richard-Toll. Each of these stations is supplied with a petroleum motor, two rotary gins, and a hydraulic press. In Dahomey the work is virtually completed. Two small hand machines have been sent to the Ivory Coast, and a new roller gin has been supplied to the station at Philippeville, Algeria. In the Sudan a new station has been installed at M'Psoba in the Koutiala region, which produces an important quantity of cotton, and where it is expected that fifty tons of fibre will be ginned this year. Experiments conducted under the supervision of an Egyptian expert to determine whether cultivation of cotton in Senegal with the aid of irrigation is possible, are thus referred to:—"Two hectares (about five acres) at the station were laid out, broken up, fertilized with farm manure and chemicals, and planted with several Egyptian and American varieties. At the same time ten hectares (about twenty-five acres) of the surrounding land were prepared. Trained oxen were scarce and the natives had to be taught how to cultivate the ground. The plant was normal but developed rather more rapidly than in Egypt. The crop reached full maturity. Some of it has already been shipped to Havre to be ginned. The yield is expected to be more than 1,100 lbs. to the hectare (approximately 450 lbs. to the acre). This compares favourably with what is done on the best fields in Egypt. One important result of the experiment will be the elimination of all varieties except the Mit Afifi and some Mississippi cotton in future experiments." Results in the Sudan were entirely satisfactory. About 75,000 lbs. of cotton were exported to France in 1909, and of this 4,000 lbs. were produced by a native who co-operates with the French Colonial Cotton Association. The rainfall during the season was satisfactory, and the yield at all stations in the territory was very good. A new ginning plant is to be established at Koutiala. The Sudan cotton is said to be of excellent quality, and sold in France at a good price. Of Dahomey and the other colonies it is said that, so far as the former is concerned, the results indicate a decided advance, inasmuch as the production is expected to reach 150 tons. The 1909 season was one of excellent rainfall, and the natives considerably increased their plantations of cotton in the certainty that they would be able to sell their crops to the agents of the French Colonial Association. In the other colonies cotton cultivation continues to progress. In south-west Africa the British Government has been assisting in experiments which have been carried on with evident success for a number of years, covering a field vastly larger than that of the French.

HOME INDUSTRIES.

Protection and the Cotton Industry.—Mr. C. W. Macara is an acknowledged authority on the cotton industry, and he has just published a statement respecting the effect of Protection upon that industry which deserves careful study. Our pre-eminent supremacy in the neutral markets—Turkey, Persia, India, China, South America—which form the backbone of our export trade, is admittedly due to the low cost of production; and low cost of production is due not to low wages and long hours of labour—wages are higher and hours shorter in Lancashire than in any cotton manufacturing district in the world—but to an economical first outlay on business and machinery, to highly efficient labour, to efficient specialisation in the

various processes of the industry, and to the fact that the many industries subsidiary to the cotton trade, and dependent upon it as their market, are themselves, under present circumstances, able to supply the cotton trade with their productions at the lowest cost. Assuming that the effect of a policy of Tariff Reform would be to raise by 5 per cent. only the cost of such materials as tools, timber, cement, glass, paint, leather and machinery, Mr. Macara puts the added cost of equipping a cotton mill of 80,000 spindles at £3,750, and the extra charge in working expenses at £613 a year, while a rise in such prices by 10 per cent. would increase the first outlay to £7,500, and the annual working expenses by £1,226. A proportional added first cost and extra working expenses would be incurred for weaving sheds. For bleaching, the addition to the cost of production on a 5 per cent. rise in cost of building and materials Mr. Macara puts at 2½ per cent., and, on a 10 per cent. rise, 5 per cent.; while in a printing and dyeing business employing a plant worth £50,000, a 5 per cent. rise in materials would mean an addition to cost of production of from £1,500 to £2,000 a year. In addition, there would be the rise in charges for railway carriage following on the general increase in the cost of living. What is the margin of net profit in the cotton industry? Mr. Macara puts it at 5 per cent. only. If that is so, and Mr. Macara's calculations as to the increased cost of production through Protection are trustworthy, the effect of the acceptance of Tariff Reform would be in some branches of the cotton industry to extinguish altogether any return on the capital invested, and in others to reduce that return to so low a point that no new capital could be attracted to it. Assuming Mr. Macara to be correct in his figures, his conclusion that a protective system would be a death-blow to the cotton industry can hardly be contested. And on the cotton trade, and the trades related to it, depends a population of not less than 3,000,000 people—one in every ten in England and Wales.

The Scottish Mineral-Oil Trade.—Recently the Standard Oil Company made certain minor concessions with the view of attracting the custom of contributors. Now the Scottish Oil Company have announced the increase of the allowance for returned barrels from 5*s.* to 5*s.* 3*d.* each as a counter concession. The days of the wooden oil barrel are probably numbered. Distribution by tank-waggon is steadily growing in favour with both wholesalers and retailers, it being recommended by its greater convenience, cleanliness, and economy. But certain vested interests seem to be blocking the way to a general adoption of a very desirable reform.

The Rise in Glycerine.—During the last eighteen months the price of glycerine has risen over 50 per cent., and last week the highest price on record was touched, there being a further advance of £5 per ton. This great rise in price affects many industries, and is said to be due largely to the scarcity of fats and oils from which glycerine is made as a by-product in the manufacture of soap, and the increased demand for glycerine for the manufacture of high explosives, great quantities of which are required for the construction of the Panama Canal and other great engineering works.

The Boilermakers' Lock-out.—This lock-out continues without any signs of early ending, and with great loss to all concerned. The men are said to be more determined than ever in their opposition to the terms of the York agreement, and it is said that there has been a substantial response to the appeal for funds to support them. But no response, however liberal, can do very much to alleviate the hardships caused by the lock-out. The boilermakers have been getting ten shillings per week for fully-qualified members, but that can no longer be paid, and the boilermakers when at work are amongst the best paid of artisans, earning from £3 to £5 per week. It is impossible to measure the loss already incurred by the shipbuilding industry owing to the lock-out. Many orders for new ships from foreign owners have been lost, and much repair work, and work under surveyors for classification purposes, has had to be sent to foreign yards. And of course it is not only the shipbuilding trade that is suffering. When the shipyards are idle many trades suffer. Now that the shipyard ironworkers have been idle for three months, woodworkers, painters, cabinet-makers, brass-founders and finishers, plumbers and many others, are out of employment, and this necessarily restricts the several productive industries with which they are associated. Shopkeepers, too, both wholesale and retail are suffering. It is estimated that the dismissed members of the Boilermakers' Society have lost in wages in the three months as much as half a million sterling, and quite possibly more, and this loss of wages is only a part of the loss in circulating medium in the form of wages, for the loss of wages in other branches of the industry by consequent unemployment must now be very heavy. And the effect of the lock-out on the iron and steel industries is most serious, for in the neighbourhood of the shipbuilding districts at least 50 per cent of the production of the steelworkers is in shipbuilding material.

Produce of Crops.—It appears from the Preliminary Statement showing the estimated total produce and yield per acre of the corn, pulse, and hay crops in Great Britain in 1910 that the wheat crop of the present year was much worse than in 1909, a fact that will surprise many. The average estimated yield per acre was only 31·10 bushels as against 33·61 bushels in 1909, and 31·47, the average of the ten years 1900–1909. The acreage, too, shrank from 1,734,236 to 1,716,629.

Nevertheless the total production of wheat, while less than last year by about 600,000 quarters, is above the ten years' average, mainly in consequence of an increase of acreage in recent years. Barley is slightly above the average yield in Great Britain, but it is less than in 1909 by three bushels per acre. Oats are the best of the corn crops, with a yield per acre of over one bushel above average. The hay crop, both from arable and meadow land, is above the average by nearly 2 cwts. per acre in the one case and 1½ cwts. in the other. Altogether, 9½ million tons of hay were grown this year as compared with less than 8½ million tons in 1909. The average annual production is about nine million tons. Another Preliminary Statement just issued gives the estimated total produce and yield per acre for the potato and root crops. The most striking feature of the latter return is the decrease in the acreage under potatoes. The yield per acre was slightly larger than in 1909, and 10 cwts. above the decennial average, but owing to the reduction in acreage the total crop is smaller by 200,000 tons than last year, and nearly half a million tons less than in 1908. The acreage fell from 3,674,453 to 3,478,289 acres, but the shrinkage is almost entirely confined to England and Wales.

CORRESPONDENCE.

YERBA (OR MATÉ) TEA.

In reference to the notice in the Society's *Journal* of November 25th, I think it worth while to point out that the "tea" is valuable to dyspeptics, from the almost entire absence of tannin. Also I have had independent testimony that it possesses a food value or sustaining power resembling that of the kola nut. The small stalks as well as the leaves are dried and ground more or less finely, but scarcely to the extent of pulverization. Another advantage is that it will bear re-infusion or decoction. Milk is unsuitable; and to my taste the beverage is at its best with sugar and a small slice of lemon in the cup.

The flavour is generally liked by Europeans after a few days' use. JOHN RYLE.

OBITUARY.

DORABJEE PESTONJEE CAMA.—Mr. Dorabjee Pestonjee Cama died at his residence in Notting Hill on Wednesday, November 23rd, at the age of 78. Mr. Cama became a member of the Society in 1871, soon after he settled in London, and in association with Mr. M. H. Cama, Mr. K. R. Cama, and Mr. Dadabhai Naoroji, who still survives, established the firm of Bombay merchants which soon became the leading Indian firm in London of that character. Mr. Cama was highly respected by his compatriots, and for many years past was considered the head of the Parsi community in London. He acquired considerable wealth, which he employed in many charitable works, including the building of the Cama Hospital for Women, Bombay, and was a liberal subscriber to the Masonic and other charitable institutions. He was the founder of "The Zoroastrian Fund," now known as "The Parsi Association of Europe," and to the last was one of its principal supporters. He was buried in the Parsi cemetery at Brookwood last Saturday, the 26th November.

ALEXANDER ROGERS.—Mr. Alexander Rogers, late Bombay Civil Service, died at his residence in Clanricarde Gardens, Bayswater, on the 27th ult. He was appointed from Haileybury in 1845, and, after serving in the Bombay Revenue and Judicial Department, he was appointed collector and magistrate successively at Broach, Ahmadabad and Surat. In 1865 he became Revenue and Police Commissioner, Northern Division, and in 1872 Member of Council, Bombay. He retired from the Service in 1879.

Mr. Rogers, who was well known as a Persian and Indian scholar, translated three modern Persian plays and "Yusuf and Zuleika." He also edited the "Bostan" of Saladi, and wrote a "History of the Land Revenue Settlement of Bombay." He became a member of the Royal Society of Arts in 1878. Since 1892 he served on the Indian Section Committee. He seldom missed a meeting of the Indian Section, taking part in the discussions on many occasions, and he contributed a large number of letters, mainly on Indian subjects, to the *Journal*.

NOTES ON BOOKS.

AN IMPERIAL COMMONWEALTH. By C. Reginald Enock, F.R.G.S. London: Grant Richards. 3s. 6*d*. net.

In February last Mr. Enock read before the Colonial Section of the Society a Paper entitled "Imperial Colonial Development," in which he proposed that each municipality or administrative unit in the United Kingdom should purchase or acquire by other means, a particular tract in the oversea states of the Empire, and that such districts should be developed as settlements for emigrants from the places with which they would be connected. The paper aroused considerable public interest and comment in the press. As it appeared so recently in the *Journal*, it is hardly necessary to recapitulate its principal points. Mr. Enock is an engineer and a traveller who has seen a great deal of the world, especially of its less well-known parts, and he has been deeply impressed with the contrast between the overcrowded state of the homeland and the lack of population in many of our colonies. He also strongly disapproves of the manner in which

various colonial governments bid against one another for desirable immigrants, and give away to persons of all nationalities vast tracts of land which, he contends, are the birthright of the British alone.

In the present volume these various points are developed at length. Perhaps the chief addition is the last chapter. Here he describes the "Commonwealth Council," which he proposes, as an Expert Chamber to undertake "the systematic and scientific conservation and development of the resources of the Empire for the benefit of its people." It is to consist of representatives of various public bodies possessing expert knowledge of the country, *e.g.*, the learned societies, steamship and railway companies, banks, etc.—"in brief, every constituted body of importance should send its delegates, and all should draw professional fees." The first task of this body "would be a scientific, practical tabulation of the land and other resources of the whole Empire. That being done, the principle advocated here of the allotment of areas of fertile colonial territory to organisations of ratepayers, or of municipal authorities, or both, would be brought forward actively. Every encouragement and stimulation would be given for the formation of these, and as far as were desirable the way pointed to the raising of the working capital. The machinery for the semi-penal control of the 'unemployables' as outlined in another chapter would be urged. The tabulation of the capabilities and defects of the home population would run hand in hand with the organisation and development of the Imperial resources."

Mr. Enock writes with much enthusiasm in setting forth his scheme, which, whatever may be urged against it, cannot be said to be lacking in originality and boldness.

Alphabets Old and New. By Lewis F. Day. Third Edition, revised and enlarged. London: B. T. Batsford. 5*s*. net.

The third edition of the late Mr. Day's volume contains no fewer than two hundred and twenty-four alphabets, ranging from the earliest period to the present day. They are disposed as far as possible in chronological order, with a descriptive list giving the sources from which they were obtained, and they are followed by a collection of ancient numerals and some fifty examples of ampersands. An introductory article, entitled "Art in the Alphabet," contains an interesting historical account of the development of lettering to guide the student in his own further experiments in design. A considerable number of modern examples are included, among the designers being Mr. Walter Crane, Professor Selwyn Image, Mr. Walter West, Professor Beresford Pite, and the author himself.

The work has been carried out with that artistic care and completeness which characterised all that Mr. Day undertook, and it should prove of great value to architects, sculptors, designers, draughtsmen, and art-workers generally.

GENERAL NOTES.

The Australian Dried Fruit Trade.—According to the American Consul at Melbourne, the production of currants in South Australia and Victoria in 1909 amounted to 36,378 cwts., and the quantity of oversea fruit cleared for home consumption, duty paid, was 54,162 cwts., so that approximately the total home consumption was 90,540 cwts. In the 1910 season the local production in South Australia and Victoria reached 63,460 cwts., so that it would appear that imports of about 27,080 cwts. of foreign fruit would suffice, as compared with 54,162 cwts. imported in 1909. Thus the gain in local production is an important factor, especially as the crop oversea is reported to be short. It should be noted that the duty-paid clearances of oversea fruit in 1909 were larger than usual. The production of all raisins in Victoria and South Australia in 1909 was 97,543 cwts., of which 7,602 cwts. were exported, and about 2,000 cwts. used for distilling, leaving a net local supply for the market of 87,941 cwts. To this has to be added 8,199 cwts., mostly sultanas, oversea fruit cleared, duty paid. Apparently, therefore, Australia's requirements for consumption in 1909 was 96,140 cwts. In the 1910 season the production of raisins in Australia was 108,852 cwts., so that apparently there was a surplus of about 12,712 cwts. But there have been shipments to New Zealand, and imports of foreign fruit to be considered. The figures of production of the two classes of raisins in the two principal States for the 1910 season were:—sultanas, Victoria, 49,810 cwts.; South Australia, 11,296 cwts.—total, 61,106 cwts. Other raisins:—Victoria, 31,234 cwts; South Australia, 16,512 cwts.—total, 47,746 cwts.

A New Fuel for the Sudan.—The Berlin correspondent of the *Times* sends some interesting particulars of the trials recently carried out at the Christoph Friedrich Works at Merseburg, and by Messrs. R. Wolff at Magdeburg, in connection with a new fuel which it is proposed to manufacture from the rank growths of reed on the upper reaches of the White Nile, locally known as "Sudd." These reeds extend over an area estimated to cover some 35,000 square miles, and the Government have to maintain dredgers to keep channels open through the morass. For some 200 miles it is impossible to secure fuel of any kind, as the river channel has no banks, and the dredgers are dependent for their coal supply on Khartum. The present price of coal, or coal briquettes, at Khartum is about 66*s*. a ton, while wood is little cheaper. "It is now proposed to convert the Sudd itself into briquettes, which can be used as fuel. The Sudd will be cut close to the water level by a machine carried on a boat, which is being specially constructed. It will be chopped in this machine and passed into barges, from which it must be transferred to a station

on shore. After a short period of drying the chopped reeds will be put into machines, called disintegrators, by which they will be ground into loose chaff. From the disintegrators the material will be automatically fed into briquetting machines, by which it will be compressed into the form of briquettes similar in shape and cubic capacity to brown coal briquettes. The machinery employed is simple, with the exception of the briquetting machines, in which a high compressing power is required. It is proposed to instal machines capable of dealing with fifty tons of fuel a day. No foreign binding material will be employed, so that when the initial plant has been installed it is hoped that the expenses for the transport of material will be very small."

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock :—

December 7.—Vaughan Cornish, D.Sc., F.G.S., F.C.S., "The Panama Canal in 1910." Sir William H. White, K.C.B., F.R.S., will preside.

December 14. — Reginald A. Smith, B.A., F.S.A., "A New View of Roman London." George Laurence Gomme, F.S.A., will preside.

Indian Section.

Thursday afternoon, at 4.30 o'clock :—

December 15.—Robert Fellowes Chisholm, F.R.I.B.A., F.S.A., "The Taj Mahal and its Relation to Indian Architecture." Sir William Lee-Warner, K.C.S.I., Chairman of the Indian Section Committee, will preside.

Cantor Lectures.

Monday Evenings, at 8 o'clock :—

Charles R. Darling, A.R.C.Sc.I., F.I.C., "Industrial Pyrometry." Four Lectures.

Lecture III.—December 5.—Laws of resistance to electricity—Siemens' resistance pyrometer—Callendar's pyrometer — Principles of resistance measurement—Temperature indicators for resistance pyrometer—Callendar's recorder—Northrup's recorder—Special uses and limitations of resistance pyrometers.

Lecture IV.—December 12.—Radiant energy—The "fourth-power" law—Laws of Wein and Planck—The Féry radiation pyrometers and indicators—The Holborn-Kurlbaum optical pyrometer —Wanner's pyrometer—Other optical pyrometers —Special uses of radiation pyrometers in pottery manufacture and work at very high temperatures.

Papers to be read after Christmas :—

Horace M. Wyatt, "Motor Transport in Great Britain and the Colonies."

Philip Joseph Hartog, M.A., B.Sc., "Examinations and their bearing on National Efficiency."

J. C. Medd, "The Dutch Labour Colonies."

Cyril Davenport, "Illuminated Manuscripts."

George A. Stephen, "Modern Machine Bookbinding."

Professor J. Wertheimer, B.Sc., B.A., "Water-Finders."

Captain A. J. N. Tremearne, "Some Nigerian Head-Hunters."

Hon. Sir Richard Solomon, K.C.B., K.C.M.G., K.C.V.O., K.C., M.A., High Commissioner for the Union of South Africa, "South Africa before and after the Union."

F. Douglas Osborne, M.Inst.M.M., "The Tin Resources of the Empire."

Reginald Murray, "Indian Banking."

R. A. Leslie Moore, I.C.S. (retd.), "Indian Superstitions."

Captain R. Muirhead Collins, C.M.G., "Australia and her Resources."

Frank M. Andrews, "Architecture in America."

Arthur Charles Davis, F.C.S., Assoc.Inst.C.E., "The Manufacture and Testing of Portland Cement."

George B. Heming, "Art Education in Jewellery and Goldsmithing."

Colonel Charles Edward Cassal, V.D., F.I.C., "The Adulteration of Food."

Dr. Leonard Hill, F.R.S., "Caisson Sickness and Compressed Air."

Sir William Abney, K.C.B., D.C.L. D.Sc., F.R.S., "The Quantitative Measurement of Colour-Blindness."

Hal Williams, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

Noel Heaton, B.Sc., F.C.S., "The Production and Identification of Artificial Gems."

Indian Section.

Thursday afternoons, at 4.30 o'clock :—

January 19, February 9, March 16, April 27, May 25.

Colonial Section.

Tuesday afternoons, at 4.30 o'clock :—

January 31, February 28, April 4, May 9.

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Frederick Wedmore, "Etching": 1. "The Old Masters;" 2. "Modern Etching." Two Lectures.

January 23, 30.

Professor Adrian J. Brown, M.Sc., "Brewing." Four Lectures.

February 6, 13, 20, 27.

Professor J. A. Fleming, M.A., D.Sc., F.R.S., "Applications of Electric Heating." Four Lectures.

March 6, 13, 20, 27.

ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

May 1, 8, 15, 22.

JUVENILE LECTURES.

Wednesday evenings, January 4 and 11, 1911, at 5 o'clock:—

Professor ARTHUR MASON WORTHINGTON, C.B., M.A., F.R.S., "A Study of Splashes, conducted by the aid of Instantaneous Photography." Two Lectures.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DECEMBER 5...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. C. R. Darling, "Industrial Pyrometry." (Lecture III.)

Farmers' Club, Whitehall Rooms, Whitehall-place, S.W., 6 p.m. Annual General Meeting. Paper on "Sugar Beet."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

British Academy (in the Theatre, Burlington House, W.), 5 p.m. The Very Rev. George Adam Smith, "The Early Poetry of Israel in its Physical and Social Origins." (Lecture II.)

Engineers, Caxton Hall, Westminster, S.W., 7.30 p.m. Mr. R. Brown, "The Working of the Road Development Act, 1909."

Chemical Industry (London Section), Burlington House, W., 8 p.m. 1. Mr. Puran Singh, "The Analytical Constants of Shellac, Lac-resin and Lac-wax." 2. Messrs. W. P. Dreaper and A. Wilson, "Theory of Dyeing: Resolution after Treatment with Acids, etc." 3. Mr. A. Kesava Menon, "Some Indian Oils and Fats."

Geographical, Burlington-gardens, W., 8.30 p.m. Mr. J. Howard Reed, "The Geographical Aspects of the Problem of Empire Cotton Growing."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. R. Blomfield, "Pierre Lescot and Jean Goujon."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Oscar Browning, "The Study of History."

Engineers, Cleveland Institute of, Corporation-road, Middleborough, 7.30 p.m. Professor W. A. Bone, "The Present State of Science on Gaseous Explosions."

London Chamber of Commerce, Oxford-court, Cannon-street, E.C., 2.30 p.m. Major E. H. M. Leggett, "Trade Prospects in British East Africa and Uganda."

East India Association, Caxton Hall, Westminster, S.W., 4 p.m. Mr. R. A. Leslie Moore, "India and Tariff Reform."

TUESDAY, DECEMBER 6...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. H. K. G. Bamber's Paper, "Portland Cement, and the Question of its Aeration."

Aeronautical (at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 8 p.m. Mr. W. H. Dines, "The Practical Application of Meteorology to Aeronautics."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. W. H. Smith, "Modifications in Platinotype and Recent Improvements."

Horticultural, Vincent-square, Westminster, S.W., 3 p.m. Mr. C. Herman Senn, "The Cooking of Vegetables."

WEDNESDAY, DECEMBER 7...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. Vaughan Cornish, "The Panama Canal in 1910."

Geological, Burlington House, W., 8 p.m.

Royal Agricultural, Agricultural Hall, Islington, N., 3 p.m. Annual General Meeting.

British Academy (in the Theatre, Burlington House, W.), 5 p.m. The Very Rev. George Adam Smith, "The Early Poetry of Israel in its Physical and Social Origins." (Lecture III.)

Public Analysts (in the Chemical Society's Rooms, Burlington House, W.), 8 p.m. 1. Messrs. Edward Cahen and Harry F. V. Little, "On Fischer's Modification of Volhard's Method for the Estimation of Manganese, and its Comparison with other well-known Methods." 2. Messrs. Edward Russell and T. R. Hodgson, "Note on the Composition of British Wines." 3. Dr. E. Knecht and Mr. E. Hibbert, "A new Volumetric Process for the Estimation of Tungsten." 4. Dr. E. Knecht and Mr. F. W. Atack, "A new Volumetric Process for the Estimation of Molybdenum." 5. Mr. H. Droop Richmond, "The Degree of Accuracy with which the Proteins of Milk can be estimated by the Aldehyde Method." 6. Mr. Edward Hinks, "Note on Gorgonzola Cheese." 7. Dr. E. H. Hankin, "Tests for Cocaine and certain Cocaine Substitutes."

United Service Institution, Whitehall, S.W., 3 p.m. Rev. Dr. Belcher, "The American War of Independence, with special reference to the Expedition from Canada in 1777."

Entomological, 11, Chandos-street, W., 8 p.m.

Royal Archæological (at the Society of Antiquaries, Burlington House, W.), 4.30 p.m. Rev. Dr. J. Charles Cox, "The Assize Rolls and Coroner's Rolls of Yorkshire as illustrating the Abjuration of the Realm by Sanctuary Seekers."

Sanitary Engineers, 120, Victoria-street, S.W., 8 p.m. Mr. G. W. Chilvers, "The Mechanics of Municipal and Sanitary Engineering."

Engineers, Junior Institution of, Caxton Hall, Westminster, S.W., 7.30 p.m. Mr. L. W. J. Costello, "Law Relating to Engineering." (Lecture V.)

THURSDAY, DECEMBER 8....Brewing, Institute of, Midland Counties Section, White Horse Hotel, Birmingham, 8 p.m. Mr. J. O'Sullivan, "An Improvement in the Method of Malt Analysis."

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Auctioneers, 34, Russell-square, W.C., 7.45 p.m. Mr. W. Bridgman, "Auctioneering in Rhodesia."

London Institution, Finsbury-circus, E.C., 6 p.m Professor Vivian B. Lewes, "Smoke and its Prevention."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. W. S. Routledge, "With a Prehistoric People."

Electrical Engineers, Victoria Embankment, W.C., 8 p.m. Sir R. Hadfield and Professor B. Hopkinson, "The Magnetic Properties of Iron and its Alloys in Intense Fields."

FRIDAY, DECEMBER 9...Illuminating Engineers (at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 8 p.m. Professor E. W. Marchant, "Recent Progress in Electric Lighting."

Water Engineers (at the Geological Society, Burlington House, W.), 2 p.m. Discussion on paper by Mr. E. Young Harrison, "The Wellingborough Waterworks and Softening Plant."

Astronomical, Burlington House, 5 p.m.

SATURDAY, DECEMBER 10...Water Engineers (at the Geological Society, Burlington House, W.), 10.30 p.m. 1. Mr. S. C. Chapman, "Gauging and Recording the Flow of Streams." 2. Mr. F. Graham Fairbank, "The Advantages of Co-operation in Rural Water Supplies." 3. Mr. Leslie C. Walker, "The Eliminating Effect of Chlorine on the Bacteria of a River Water."

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FRIDAY, DECEMBER 9, 1910.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 12th, 8 p.m. (Cantor Lecture.) CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "Industrial Pyrometry." (Lecture IV.)

WEDNESDAY, DECEMBER 14th, 8 p.m. (Ordinary Meeting.) REGINALD A. SMITH, B.A., F.S.A., "A New View of Roman London." GEORGE LAURENCE GOMME, F.S.A., will preside.

THURSDAY, DECEMBER 15th, 4.30 p.m. (Indian Section.) ROBERT FELLOWES CHISHOLM, F.R.I.B.A., F.S.A., "The Taj Mahal and its Relation to Indian Architecture." Sir WILLIAM LEE-WARNER, K.C.S.I., will preside.

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES ON "INDUSTRIAL PYROMETRY."

On Monday evening, the 5th inst., Mr. CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., delivered the third lecture of his course on "Industrial Pyrometry."

The lectures will be published in the *Journal* during the Christmas recess.

CANTOR LECTURES ON "THE ART AND HISTORY OF BRITISH LEADWORK."

The Cantor Lectures on "The Art and History of British Leadwork," by Mr. Lawrence Weaver, F.S.A., have been reprinted from the *Journal*, and the pamphlets (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John-street, Adelphi, London, W.C.

A full list of the Cantor Lectures which have been published separately, and are still on sale, can also be obtained on application to the Secretary.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be delivered on Wednesday afternoons, January 4th and 11th, at 5 o'clock, by ARTHUR MASON WORTHINGTON, C.B., M.A., F.R.S., Professor of Physics in the Royal Naval Engineering College, Devonport, on "A Study of Splashes, conducted by the aid of Instantaneous Photography."

Each Member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to Members in the order in which applications are received.

Members who desire tickets for the course are requested to apply for them at once.

COLONIAL SECTION COMMITTEE.

A meeting of the Committee of the Colonial Section was held on Tuesday afternoon, the 6th inst. Present:—

Lord Blyth (Chairman of the Committee) in the Chair, Sir John Cameron Lamb, C.B., C.M.G. (Chairman of the Council), Byron Brenan, C.M.G., Richard Ernest Brounger, Hon. Sir John A. Cockburn, K.C.M.G., Edward Dent, Hon. Sir Charles W. Fremantle, K.C.B., Robert Kaye Gray, Alexander Siemens, Sir William Hood Treacher, K.C.M.G., with Sir Henry Trueman Wood, Secretary of the Society, and S. Digby, C.I.E., Secretary of the Section.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A Meeting of the Colonial Section was held on Tuesday, November 29th, Admiral Sir Frederick George Denham Bedford, G.C.B., late Governor of Western Australia, presiding.

The paper read was—

THE PROGRESS AND PROSPECTS OF MINING IN WESTERN AUSTRALIA.

By A. Montgomery, M.A., F.G.S.,
State Mining Engineer of Western Australia.

In coming before you to-night it is my pleasing duty first to acknowledge the great indebtedness of the State I have the honour to represent—and of myself personally—to the Royal Society of Arts, in affording this opportunity of addressing an audience in the heart of the Empire on the subject of the mining industry of a member of the Imperial body so distant as Western Australia. It is very appropriate that such a subject should be dealt with before the Royal Society of Arts, for is not mining one of the foundations of all the arts and manufactures, one of the great prime industries at the root of all our commerce, one of the most necessary essentials of our civilisation ? The physical wants and needs of mankind are many, but the provision for all of them rests fundamentally and first of all upon obtaining food and the raw materials of manufactures, and among the latter it takes more than a little reflection before one can realise adequately and fully the enormous importance of the materials which are extracted from the earth by processes of mining. Without metals and minerals civilised life is impossible, and it is as much a necessity of the world's prosperity that the mining industry should be in a healthy and flourishing condition as that the food supplies should be adequately provided for. It is a noteworthy fact that there is no leading nation or state in the world which does not depend very greatly on its mineral resources as the foundation of its strength, our own Empire showing many of the most notable examples. How futile, then, is it to prose about the risky nature of mining as an investment, and to look upon it, sagely, as being of such a nature that no prudent business man will concern himself with it ! Willy-nilly, it will concern him sooner or later if neglected, for it lies beneath all his carefully-reared industrial structures, and can no more be neglected with impunity than the maintenance of the supplies of food or clothing for the population. Both are equally elementary necessities. This view of the position of mining is doubtless a commonplace to many here present, but it is not entirely useless to repeat well-known elementary principles from time to time, and the absolute necessity for the maintenance of an active mining industry as the base of industrial prosperity seems so often to be overlooked that I may, perhaps, be forgiven for insisting on its vital importance.

The State of Western Australia, like all the other States of Australia, has owed its first great advance towards industrial importance to its mineral wealth, its gold discoveries attracting population and providing means whereby the country has been opened up for more permanent settlement. Other industries have followed, greatly encouraged in their inception by the excellent local market afforded by the goldfields, until one frequently hears now more said about the opportunities of settlement upon the lands of the State, and of engaging profitably in pastoral and agricultural pursuits, and in fruit-growing, than of those for mineral development. This is quite in the natural order of things, as has been exemplified previously by California, Victoria, South Australia, and many other countries, and if it were my province to do so here to-night, it would be a pleasure to lay before you some facts as to the immense progress recently made in our State in wheat and fruit-growing, and farming and pastoral pursuits of all sorts, and to point out with all the enthusiasm at my command the excellent opportunities for settlement on the lands of Western Australia which are open to any people of this country who may be desirous of trying their fortune in other lands. That subject, however, I must leave to some of my friends, and confine myself now to consideration of the mining position in the State. But first let me repeat a few general facts about the country, in order to enable those present who may know nothing about it to realise somewhat better the leading conditions under which mining is carried on.

Western Australia is a vast country, justly described as one of "magnificent distances." It

comprises 975,920 (or nearly a million) square miles, and extends over twenty-one degrees of latitude, the north part being within the tropics (in 14° south latitude) and the south approaching the cooler portion of the temperate zone (in 35° south latitude). The climate, therefore, is very different in different parts of the State. There is a good rainfall along most of the west coast, averaging thirty to forty inches annually, but as we go inland it decreases, and on about 57 per cent. of the area of the State the annual rainfall is under ten inches. Sub-arid conditions, therefore, prevail in a large portion of the interior, and provision of permanent supplies of fresh water becomes a first necessity of settlement. In the summer months the shade temperature often rises to over 100°F., and in the tropical parts of the country there is naturally a high average annual temperature, but south of the tropics for the greater part of the year the climate, though warm, is not by any means excessively hot, and in winter it is often quite cold, with occasionally frosts at night. The dryness of the atmosphere enables people to endure a much higher temperature without discomfort than is possible in more humid regions. On the whole, the climate of sub-tropical Western Australia must be regarded as an exceedingly pleasant one, and even within the tropics it has been found that Europeans can live and work with much comfort and excellent health.

There are no high ranges in Western Australia, the altitude of its highest portion being only about 4,000 feet. The greater part of the interior of the country consists of plains 1,000 to 1,500 feet above sea-level, broken by low ridges and island-like low hills. Over the main portion of the central and eastern goldfields there are very few outstanding ranges of hills of any magnitude, but from Peak Hill northwards the country becomes much more hilly, and distinct mountains of some altitude are often visible. In the south of the State also there are some fairly high and steep mountain ridges. There is, however, no great range sufficient to form a source of permanent rivers, and, except in the north-west and south-west regions, where there is a good rainfall, running streams are unknown except during rains. The plains are generally very flat basins dipping towards depressions occupied by salt lakes and saline clay pans. On the edges of these plains there are very often precipitous escarpments ten to fifty or more feet high, known locally as "breakaways," which mark the margins of old lake basins of which the plains were the bottoms. At the top of the escarpments we frequently come on small plateaux, often very level, which are relics of an older marine plain, and on these there are frequently sand dunes, fringing the old lake basins. In the lake-basins the bed-rock is often at a very shallow depth beneath the surface, or even outcropping, but frequently it is covered with detrital material to considerable depths, many wells being sunk seventy to eighty and even over one hundred feet before reaching the bed-rock. It is plain, therefore, that in those old lake basins there has been a great deal of levelling up of old hollows in the bed-rock with detrital materials.

In the districts of the south-west portion of the State, where there is a fairly good rainfall, there are extensive forests of heavy timber, and more inland there are still good timbered belts, which provide excellent firewood and mining timber for the mines. In the Murchison and Mount Margaret districts, however, the heavier eucalyptus timber is replaced by small trees ("mulga"), which supply good firewood and make useful but not first-class mining timber. Still further north the country becomes very open, and is covered with various varieties of grass and spinifex, forming good pastoral country. In these parts of the country it is often very difficult and expensive to procure mining timber and firewood, the trees being confined to narrow belts along the main watercourses. The country is, as a rule, remarkably easy to traverse, there being little or no difficulty, other than that of obtaining water, in taking vehicles over it in any direction without having to make roads. The "bush" is very open, and can often be traversed quite readily in a buggy, or even, in a good many places, in a motor-car. This ease of getting about explains at once the extraordinary way in which the goldfields were overrun by prospectors within the first ten years of the gold discoveries. It also explains why it is possible to lay down railways for not much over £1,500 to £1,800 per mile.

Gold and other minerals are found more or less all over the explored portions of Western Australia, the principal metallic minerals being gold, tin ores, copper ores, lead ores, and iron ores, while coal is the most important non-metallic mineral. The metallic minerals occur in very old igneous and sedimentary rocks, the geological age of which is not yet determined, beyond that it is pretty certain that most of them are older than the Cambrian period. There is a very complex system of exceedingly ancient metamorphic rocks mingled with igneous

intrusives, many of which have become converted into schists, and which may be roughly grouped together as the auriferous greenstones. Breaking through these there are great granitic intrusions, which, in turn, have been pierced by later dykes, both acidic and basic, of different ages. In this great series of old rocks there are doubtless both sedimentary and igneous products of many different ages, the relations of which to one another have not yet been worked out. Lying unconformably on these oldest rocks, we find here and there throughout the country small patches of a younger but still extremely old formation of sedimentary slates and schists (known as the Mosquito Creek series), and apparently of later date than these are the fossiliferous Cambrian beds of the northern part of the State. In the north also we have a large development of Devonian rocks, and in the north and west considerable areas of permo-carboniferous strata. In the most southerly of these last the Collie Collieries have been opened up. The occurrence of patches of cretaceous marine strata and tertiary to recent limestones in widely-separated parts of the State shows that much subsidence and elevation of the country must have gone on since the coal measures were laid down, and numerous physiographical and geological considerations have led me to the conclusion that the country owes the present shape of its surface very greatly to the fact of its having been wholly or in great part submerged beneath the sea within post-tertiary times.

This very incomplete sketch of the geological history of the country may serve to assist in comprehending some of the features met with in mining in it, especially for gold. Except for coal, phosphate rock, gypsum, salt, bauxite, and some few other minerals, and when considering the distribution of alluvial gold and tin ore, we may put to one side, from a mining point of view, all the country occupied by the strata of later date than the Devonian period. In the Devonian system we have a very interesting series of auriferous conglomerates (the Nullagine conglomerates), which are in many respects closely analogous to the "bankets" of South Africa, and it is interesting to note that in these beds the gold is pretty certainly of alluvial origin, derived from the erosion of the underlying Mosquito Creek and auriferous greenstone series, both of which teem with auriferous veins. The Devonian and later strata are comparatively little crumpled by orogenic movements, and show little, if any, evidence of ever being penetrated by mineral veins, and it seems very clear that the period of formation of the mineral veins in the older rocks was long anterior to the Devonian, and probably also to the Cambrian period. All the pre-Cambrian strata, whether igneous or sedimentary, are greatly plicated and contorted, the axes of folding running north-north-westerly in the southern part of the State and north-easterly in the northern, conformably with the general direction of the western coast-line. The complex of ancient intrusive and metamorphic rocks in which the mineral veins occur, and which we now find at surface, were doubtless once deep in the base of a rising region, probably forming a mountain chain like the Swiss Alps or the Cordilleras of South America. There is much reason to regard it as most probable that the quartz veins carrying the gold and minerals were of very deep-seated origin, most of the vein stuff being really more or less sheared country rock transmuted into quartz by metasomatic change. Most probably they are the result of pneumatolytic processes operating—very likely more or less in connection with volcanic activity—during the period of mountain-forming movement, which was certainly mainly pre-Devonian and probably pre-Cambrian.

The principal gold discoveries may be arranged in belts as shown in the map exhibited, which was kindly lent to me by our Government geologist, Mr. A. G. Maitland, F.G.S. These correspond very well in direction with that of the general axes of folding of the oldest strata. It is noteworthy that the main granitic areas have so far been found to contain few mineral veins, and that the latter are usually in the greenstone schists and dioritic intrusives not far from the contacts with the granite. When payable mineral veins have been found in the granite they have in almost all cases been quite close to the greenstone contacts. Many of these contacts have probably been lines of very severe faulting movement, the greenstones along the contact being very much sheared and foliated, and the granite being also in some cases converted into schist, which a short distance away soon merges into gneiss and granite. Some of these shear zones along the granite contacts are of great length and persistency, one passing through Southern Cross, for example, being traceable for over sixty miles at least, and they are very notable as containing several important mines, and very numerous smaller auriferous veins.

The official records of mineral exports from Western Australia commence in 1850, when a

small quantity of lead ore was exported from the Northampton mineral field, and three years later a small amount of copper ore is found among the exports. Ores of these metals continued to be the principal mineral production for many years, copper mining at Northampton reaching its zenith in 1864 and lead mining in 1877. Exports of gold are first recorded from Kimberley in 1886, followed by Pilbara and Yilgarn in 1889; Ashburton and Murchison in 1891; Dundas in 1893; Coolgardie in 1894; North Coolgardie, North-east Coolgardie and East Coolgardie in 1896; Peak Hill, Yalgoo, East Murchison, Mount Margaret, and Broad Arrow in 1897; Gascoyne and Donnybrook in 1899; and Phillips River in 1902. Exports of tin ore from the Greenbushes mineral field first appear in 1889, and from Pilbara in 1893. Coal is shown for the first time in 1898; mica in 1892; while sundry other minerals, including asbestos, cobalt ore, plumbago, antimony ore, tantalite, scheelite, and wolfram appear in and after 1900.

To avoid loading my address with figures which could not be kept in mind if simply read over to you, printed slips have been distributed, with a number of tables and other figures showing leading facts about Western Australia's mining industry. These are now printed as an Appendix (see pp. 82–89).

Table No. 1 shows the mineral production of the State to end of 1909, as set forth in the returns of gold received at the Royal Mint in Perth, and the export values of gold and minerals sent out of the country. Except for a certain amount of specie and manufactured gold retained in the State, practically the whole of the minerals produced are exported with the exception of coal, limestone and ironstone. In the table the production of these latter minerals as returned by the producers is shown alongside the exports, and the difference—being the local consumption—added to the total of exports, should approximately represent the total production, which is thus seen to amount to a value of, roundly, £95,000,000, to the end of 1909.

Another very similar table is also published in the annual statistical returns of the Mining Department of the State, showing the figures of production as returned monthly by the producers, but these come out with a somewhat lower total than the export figures, though agreeing in broad general features. Mine-owners have not always been as careful as they should have been in having their production properly recorded, the total being slightly under £90,000,000 sterling to end of 1909 (£89,494,650). In both estimations there is doubtless a considerable amount of gold omitted which has been taken away by alluvial diggers and others leaving the State, especially in the earlier days.

It may be seen from the table that, out of a mineral production valued roundly at £95,000,000, about £92,000,000 have been due to gold; tin and copper ore only approaching their first £1,000,000 in value, while the advance in the annual production of coal, especially for export, is very noteworthy.

In order to show the position of the State of Western Australia as a gold-producer, I would now ask you to look at two of the tables, Nos. 2 and 3, taken from the last Year-Book of the Commonwealth of Australia, showing the world's production of gold from 1897 to 1908, and also at No. 4 from the same authority, showing the individual production of the various States of the Commonwealth. It will be seen that Australia's contribution is the vast sum of £501,474,700, and that its annual production, though still very considerable, has fallen in relative importance from 26·36 per cent. in 1900 to 14·28 per cent. in 1908, but also that this is due not to the falling off in Australia's output as much as to the immense advances in production in Africa and North America, particularly the former, where the output has been more than doubled in the last five years of the table. Among the States of Australia, Western Australia easily holds the lead in annual gold production since 1897, and, though her total output is still far below the huge sum contributed to the world's stocks by Victoria, it now exceeds that of any of the other older gold producers of Australia.

Taking other minerals as well as gold, Table No. 5 shows the total mineral production of Australasia, including New Zealand, and it will be seen that Western Australia and New South Wales are running a close race for the leading position. Another rather striking feature of the table is that it shows that there has been an almost universal decline in production in all the States of Australasia during the years 1908 and 1909, New Zealand being the only one in which the output for 1909 exceeded that of 1907. The average annual production for the eight years tabulated is in all cases, except New South Wales, greater than the 1909 output.

Let us see how mining stands statistically as regards other Australian industries. Here, again, we find a useful table in the Commonwealth

Year-Book, which is quoted (No. 6) among those in your hands. It will be seen that the value of mineral production is nearly 15 per cent. of the grand total for the whole of Australia, and in Western Australia in 1908 was nearly 50 per cent. The importance of the mineral industry to Western Australia is even more strikingly shown by Table No. 7, showing the proportion of its own mineral exports (other than coal) to its total exports. For the last ten years the average proportion is seen to be no less than 78·9 per cent., and in 1903, the year of greatest gold production, it was as high as 84½ per cent. For the last five years the ratio has been steadily falling, not only on account of a decline in mineral production, but also on account of a very gratifying advance in the production of agricultural and pastoral produce, but in 1909 it still was two-thirds of the total.

The aspect of the matter, however, which is the main concern of the British investor, is naturally that of the value of Western Australian mines from a stockholder's point of view, and here we come in contact with many considerations which tend to obscure the fundamental issues. The market value of mining shares depends on popular estimation from time to time, and fluctuations in value by no means necessarily indicate the true position of affairs at the mine. Many people make and lose money by dealing in mining companies' shares, and put their gains, and more especially their losses, down to "mining" when they are simply due to share-dealing. One may buy stock in a mine which is making very profitable returns at so high a figure that the dividends give a very inadequate interest upon the investment, but in such a case it is not the mine which is at fault, but the investor's own judgment. To try and get at some of the leading facts of the case from a purely industrial point of view, let us look at Table No. 8, showing the amount of dividends paid by Western Australian gold-mining companies in comparison with the total production. It will be seen that the average return has been 22·1 per cent. of the total produce, and that the dividends have ranged from 18 per cent. to 26·1 per cent. of the total production, which is a very favourable showing for any industry. As, however, this way of looking at the question shows only the percentage of the total production paid in dividends to registered companies, and leaves out of account a large number of small mines privately owned, many of which are very profitable, the last two columns have been added to the table to show the ratio of the dividends to the value of the gold produced by the registered companies alone for the last three years, and it is seen that the dividends have amounted to an average of 27·6 per cent. of the total production of all the registered companies. The very profitable nature of the gold-mining industry is very well shown in another way by stating that the average value of gold produced per man employed, both on surface and underground, was £444 in 1908 and £413 in 1909.

Taking another basis, I find from Table No. 7 in the annual report of the Mines Department for 1909 that dividends were paid by twenty gold-mining companies, the total share issues of which amounted to 6,961,663 shares paid up to £6,913,560 10*s*. Their dividends for 1909 were £1,359,115, equal to an average of 19·7 per cent. of the paid-up capital. This is surely a very profitable return on the money invested in these companies. I regret that I have not been able to get hold of any reliable estimate of the total capital contributed by companies towards exploiting the mines of Western Australia, and it would be still more difficult to arrive at any true valuation of the amount of cash actually spent in the country—which is the true industrial basis upon which the proportion of dividends should be calculated. The twenty mines referred to are, however, the largest and most important in the State, and it is improbable that the actual expenditure from capital in the case of the other non-paying and extinct companies has greatly, if at all, exceeded the £7,000,000 spent in the equipment and development of the large producers. The total amount of dividends paid, say, £20,000,000, must be now very greatly in excess of the total cash laid out by the investors from capital in *bona fide* mining operations. I am not speaking of the return on the nominal capital of the many companies which have failed in the State in the past, as calculations on that basis seem to me to belong to the province of share-dealing, and not to mining as an industrial process, and in claiming that the Western Australian mining industry has been a highly payable one on the whole to those who have invested in it, I rest my case on the fact that far more money has already been repaid to the investors in dividends than they have laid out from capital in opening, equipping and exploiting the mines.

When one considers these very favourable results, it is somewhat difficult to understand

the adverse attitude which has prevailed in the London mining market for some years past towards Western Australian mining ventures. There is no question but that they have been greatly out of popular favour for some years past, and there seems to be a very general feeling among investors in England of great distrust of the country and disinclination even to listen to representations in its favour. One reason of this was, no doubt, the multitude of unsuccessful West Australian mining companies which were floated in the earlier days of our goldfields, from ten to fifteen years ago, through which the investing public suffered heavily. In regard to these, nevertheless, it is only just that a careful distinction be made between the losses made in stock-dealing and the actual losses on mining work. In very many cases it will, I think, be found that the heaviest portion of the losses of the shareholders was the money paid to promoters and others in forming the companies and in their own market dealings in the shares. Frequently many causes co-operated to make the ventures unsuccessful, and it is by no means either fair or reasonable to jump to the conclusion that because a mine proved unsuccessful it was necessarily an obvious "wild cat" from the inception. That there were some frauds deliberately put upon the market is likely enough, as has been the experience in every mining "boom" in every other part of the world as well, but it is rather surprising to find what a large number of cases there are in which mines opened by companies some years ago and abandoned by them as unpayable have been since worked profitably. Very many of the so-called "wild cats" were guilty of nothing worse than being prospects greatly over-rated by their discoverers and promoters, and the public who rushed to invest in them without sufficient examination were almost as much to blame for their lack of ordinary and reasonable caution as were the promoters who offered them the bait. This sort of thing happens in all "booms" more or less, and seems quite inseparable from mining-company promotion as the world is at present constituted. Many of the ventures were entirely premature, the grade of ore in the mines being unworkable profitably at the time they were taken up, though since then, under better conditions, it has been possible to re-open several of them to advantage; many were failures due to want of experience of ore deposits with the peculiar local features presented by the lodes of the West Australian fields—some were very badly managed, and some with brilliant surface prospects, as they were opened, became too poor to be followed up. It is in the nature of mining that there can be no certainty as to values in ground which has not been well proved by systematic development, and when undeveloped "prospects" are undertaken there is necessarily much risk that they may turn out badly rather than well. When an unproved property is taken in hand for mining purposes it is always well for the investors to have their minds made up that the risks of disappointment are very great, and to be prepared to follow a policy of first proving their ground well before launching out into much expenditure on plant and permanent development. It will often, in such cases, be found advisable to do a good deal of work upon quite a number of promising "prospects" before settling down in permanent fashion upon one or more of them. In the earlier days of the Western Australian boom—as in all similar cases—this elementary precaution was quite overlooked, and investors rushed madly to pay large sums for ground on which practically nothing had been proved and the value of which no man living could predict. The country is full of lodes and mines carrying more or less gold, and worth more or less prospecting, and in most cases when gold has been found in the outcrop it is quite impossible for any one to predict with any certainty whether the lode below it is going to be a good one or not. Many very promising-looking outcrops have proved very disappointing when sunk upon, and conversely poor surface indications have frequently been found to cover excellent values in depth. No one can tell how they will turn out without a good deal of development, and in the early days this was almost entirely overlooked, and investors found themselves committed to the working of reefs for which they had paid high prices, but which they would not have undertaken seriously if they had done some preliminary work upon them before completing their purchase. In such circumstances it is very natural that the owners should persevere with undertakings that would be much better left alone after the first preliminary workings have shown that the prospects were not so good as anticipated, and much money has been uselessly expended through a creditable but mistaken notion of pluck. The owners find themselves committed to a venture and determine to see it through, for better or worse. Many good mines have been found by such perseverance, and in many aspects it is highly commendable; but investors should take such risks with their eyes

open and not give way to excessive disappointment if their efforts result in failure instead of success.

Since the earlier days a great deal of valuable knowledge has been obtained as to the behaviour of the lodes of Western Australia which was not well understood at first, and there is not much fear now that the mistakes of former days will be repeated by any careful and experienced manager. Purchasers now very properly demand time to satisfy themselves thoroughly about the prospects of the properties offered to them, and do not usually complete their bargain until they have themselves developed the mines to some extent on an option of purchase. Many reefs are often thus examined before a purchase is finally completed, and the industry is put on a far sounder basis in consequence.

At this stage I must digress a little to meet a comment which is often made, and which on the face of it seems very reasonable. We are told that the British investor does not want to trouble himself with prospecting risks, but would rather put his money into concerns which have been well proved but require capital for equipment with machinery for ore treatment and further mining development. Let the local people do the prospecting and proving of the lodes, we are told, and then capital will come in freely for any genuinely good concern. This sounds very sensible, but is in truth very impracticable. It is a sort of academic platitude, quite unsuitable for practical workaday conditions. First of all, who is going to do the preliminary proving of the mines? The prospectors cannot do so as a rule themselves, being usually poor men who have to earn a living while they are doing the necessary development, and unless they have backers to find them in food and stores they cannot go on. As a matter of fact, the local residents of the goldfields, especially those in trade and business in the goldfields centres, do a great deal of backing of prospectors, but a few figures will show the magnitude of their task in Western Australia. The population of the State is now about 285,000 persons, counting men, women, and children. The area of the proclaimed goldfields is 330,126 square miles, or more than a square mile to each person in the State. The leases held in 1909 were 2,105 in number, comprising 28,919 acres, or a little over an acre to every ten persons, and this year there were also 12,465 acres held as prospecting areas as well. The mineral-bearing country extends from north to south right across the continent of Australia for over 1,300 miles. In all the mining districts there are dozens of lodes known for every one which has been tried at all seriously, and many of these lodes and veins might yet be found worth working. We are, besides, finding new ones every day as prospecting proceeds, not only in new country but also in the oldest and most worked of the fields. The multitude of lodes on which prospecting is worth doing is quite astonishing, and cannot be realised without travelling through several of the mining districts and examining them somewhat minutely. It then becomes manifest that there are still enormous opportunities for good mining discoveries, and that active and systematic prospecting can hardly fail of being sooner or later well rewarded. Instead of the fields being worked out, as some people imagine, it is seen that they have barely been begun upon, and that there must still be vast mineral wealth to reward well-directed prospecting. An excellent illustration of how little thoroughly the country has been prospected is afforded by the recent discovery of two mines, which promise to become very important, in the Southern Cross auriferous belt, the oldest of the discoveries in the eastern goldfields. One of these is only about seven miles from the original discovery at Golden Valley of gold in the eastern field. Further south, on the same belt, a large and valuable lode has been found close alongside a mine which has been working for years. Very many similar instances could be quoted.

One good reason, therefore, why the local residents do not themselves do the preliminary work of prospecting before inviting capital to come to their assistance in mining development, is that they are doing all they can already, and that the field is far too vast for the means of a small population. At the same time great attention is being paid to opening up the land of the State, and great numbers of people who might otherwise have money available for mining have their hands quite full in fencing, improving, and stocking the virgin country which they have taken up. For their numbers and means it will be found that the people of Western Australia are quite as enterprising in mining ventures as any of their neighbours, and are doing all they can, but they can only do but little in such a vast field. For every man now engaged in mining, I am convinced that the fields could easily support ten if they were adequately developed, but both population and capital are required before this can be brought about. There are great opportunities waiting to be

seized, for both capital and labour, in developing these fields. One is of no use without the other, nor either without what has been well termed the third leg, which gives stability to the industrial stool—brains and knowledge. But if capital and labour can be made to work together under intelligent and skilled organisation there is no doubt whatever that the conjunction of effort would result most satisfactorily in a field of such great potentialities as the Western Australian goldfields.

Reverting to the argument that the British investor should not concern himself with prospecting ventures, but wait till fairly well-proved mines are put before him, there is another fairly strong reason why such a policy is not the entirely admirable one it is often represented to be, and that is that the best of such concerns are apt not to come on the market at all, or only at a very high price. Why should the men who have found and proved a really good mine part with it unless at a very good price? Once large values are proved to be in sight they can usually continue to get enough money in one way or another to procure plant to enable them to realise the more easily-obtained wealth in the ground, and the mine itself then soon provides funds for further equipment. Many of the best mines in the world have thus been opened with very little assistance from outside capital, and when such mines do require large additional capital for new and heavy equipment they are usually in a position to exact very good terms for themselves. The question for an investor to consider is whether it is really his best policy to spend thousands in acquiring an interest in an already proved concern in which he can count on fairly certain profits, or to spread his risks in small sums over a large number of prospecting concerns, the success of one of which would fully compensate him for losses in all the others. I do not think it can be held to be at all well demonstrated that the former apparently safer course has, as a matter of experience, been proved to be more generally remunerative than the latter bolder and more speculative one, in which the fruits of the discovery of a good mine are preserved to the adventurers. It is very noticeable that practical mining men are usually themselves keen supporters of prospecting, risking their money to find new mines rather than investing it in going concerns, and, while this may be regarded as gambling, I am not at all sure that it is not really more properly to be recognised as the result of their intimate knowledge of the actual facts of the industry, and that they are not quite right in adopting the apparently more risky course. Search for new discoveries is a speculative venture, but it is one of the most essential factors of the industry, without which its decline and fall are inevitable; and when it involves a necessary expense and risk that are inherent in the nature of the business, it is not fair to denounce as gamblers those who prefer to undertake it rather than the less speculative work of developing the discoveries made by others. They are undertaking a very necessary part of the work, without which it cannot go on.

Of late years in Western Australia a good deal of exploration work of this nature has been done by several of the existing mining companies, with a view to providing new mines to replace their own when they may become worked out. The usual course has been for them to examine what are represented to them as promising discoveries, and if satisfied with the preliminary tests to arrange terms on which they may obtain an option of purchase over the property for a stated time, during which they undertake to do a certain amount of development work. When they have done this work they are in a position to see if the mine is worth buying or not, and can act accordingly. Many properties have usually to be examined in this way, and a good deal of money spent on them, before one quite satisfactory is found of which the purchase may be completed, and in some cases large sums of money have thus been expended without getting hold of any good mine. Several companies, however, have no reason to complain, and have been able to acquire very valuable properties. One recent good example is that of a company which is said to have expended some £50,000 to £60,000 in testing properties, but has been able to acquire as a result no less than four very promising mines which seem likely to give them good profits. As the work of selection of mines is now conducted, it is on a very business-like basis, and there is no more of the speculative and reckless purchase of unproved ground that led to so much loss in the "boom" days.

There is still a great field open for further development on the same lines, particularly if the companies undertaking such work will not despise mines of less than first-class magnitude. Hitherto the search has been mainly for lodes big enough and good enough to be worked on a fairly large scale by a single company, with mills of twenty or more heads of stamps. But such mines are very much less common than

smaller ones, which can be worked profitably with a ten-head mill or even, sometimes, with only five stamps in the case of somewhat small yet rich veins. A large number of such mines are being worked throughout the State, mostly by single local owners or small parties, who have contrived to get some machinery together, often very inadequate for cheap handling of the material, and are conducting all the operations themselves. Many of them have been successful —some very much so; but there are also very numerous instances where these mines might do very well were they not crippled by want of means. With an expenditure in plant and development of, say, £3,000 to £6,000 they could often be put in a position to go on steadily as profitable concerns, and their profits, though perhaps not great individually, would give very excellent interest on the money expended upon them. A surplus of £1,000 annually on the work of such small mines is not a great deal, but it would be 20 per cent. on an investment of £5,000 in equipping them, and even small mines when profitable at all often return far more profit than this. There seems to me to be an excellent opening for exploration companies which would take over a number of such smaller mines as well as any of the larger ones they can get, and would work them in conjunction with one another, one superintendent having general supervision of the whole of the operations and concentrating all possible office work in his own office, with only good foremen managers on the mines. Small profits from a number of individual mines would then amount to an appreciable sum in the aggregate, well worth the consideration of a fairly large company. Such a scheme is more broadly based and affords better chances of success on the average working than when the company is tied to one particular mine. It also offers advantages in the matter of allowing of transfer of plant from a property which proves a failure to some other held by the same company, without the sacrifices which invariably attend the disposal of the machinery of a mine which is given up.

While on this part of the subject it will be of interest to look over Table No. 9, the results shown in which have been worked out from the annual statistics of the Mines Department. Here we see the relative numbers for the last three years of the principal companies, which had an annual output of over 12,000 ozs., or, say, over £50,000 roughly, compared with the smaller companies and private producers making returns of a smaller amount per annum, and also the goldfields in which they are situated. Returns are shown from 166 companies in 1907, 149 in 1908, and 153 in 1909, and from 879,841, and 883 other owners in the same three years respectively. While eighteen, twenty-three, and twenty-three of the companies, produced over 12,000 ozs. per annum, the number producing over 5,000 ozs. rises to forty, forty, and forty-two in the three years. The third part of the table then shows the number of mines which individually produced over 1,000 ozs. in each of these years. Incidentally it will be seen from the second part of the table that in the more important mines the tonnage crushed has increased from year to year, although the total output of gold has diminished. This is due not altogether to falling off in the value of the ore, but greatly also to improvements in mining and milling methods, which have enabled ores lower in grade than formerly to be dealt with profitably. For example, if mining and milling costs come to nearly £4 per ton, it is clear that the ore must return an ounce or more of gold in order to yield a profit, and poorer ore is best left unbroken in the mine; but if the costs are reduced to, say, 30*s*. a ton, then 8 dwt. rock can be utilised with profit, and the reserves of ore become greatly increased. So long as there is a margin of profit on the lowest grade ore mined it is usually better policy to take it all out with the richer ore than to work out the latter by itself and then return for the poorer stuff. It is often not possible to get back to the poorer ore afterwards without much cost. The increase in the tonnage and fall in the value shown in the table is in this regard, therefore, rather an indication of strength in the mining position than the reverse. For the last ten years mining and treatment costs have been improved from year to year very steadily, until now some very low figures are shown by various companies, notwithstanding high costs of labour, and in some of the most notable cases long distance from railway communication as well.

The table also, it seems to me, indicates much vitality in the mining industry in regard to the smaller mines. It is from these that we must expect the list of the more important mines to be recruited from time to time. It is in the nature of the case that active mines must become worked out sooner or later, as there is no replacement of the ore removed, and consequently we must expect the larger mines after a longer or shorter period of production to fall off in their returns, and one after another to drop into obscurity. But if there are plenty of others

behind them to take their places there is no fear of the extinction of the industry. There seems to be a very general but much mistaken belief among the public that the day of Western Australia is over as regards mining, and that this industry must be expected soon to dwindle away to unimportance. The yearly drop in the production since 1903 is pointed out as proving this contention, quite irrespective of any consideration of the causes of the decline. When we look more into the details of the decline we find that it is largely due to the falling off in yield of a few of the largest mines and of several of the older smaller ones, which have first had several years' successful running. For example, the yield of the Great Fingall Mine fell from 99,253 fine ozs. in 1907 to 81,585 in 1908, and 41,269 in 1909; that of the Westralia Mount Morgans from 38,358 fine ozs. in 1904 to 14,993 in 1909, and that of the Great Boulder Perseverance (owing to a disastrous fire in the mill) from 70,681 fine ozs. in 1909 to very little at all in the first half of the present year.

Several districts have shown substantial increases from year to year. For example:—Black Range from 57,633 fine ozs. in 1907 to 72,388 in 1908, and 76,797 in 1909; Nannine from 31,357 ozs. in 1907 to 37,209 in 1908, and 49,953 in 1909; and Dundas from 23,449 ozs. in 1907 to 27,918 in 1908, and 27,935 in 1909. On the whole, however, the decreases in yield for the last seven years have exceeded the increases, and the production has, therefore, fallen off. Nevertheless, as Table No. 9 shows, there was a decided advance in 1909 in the production of the privately-owned leases over that of 1908, and it will be seen also that the number of mines making returns was larger than in either 1908 or 1907. The number of men engaged in mining was also larger than in 1908, giving some grounds for thinking that there are signs that the ebb in production may soon give way to an again advancing tide. What is most wanted to stimulate production is a more liberal investment of capital in searching for and opening up new mines, to make it worth while for prospectors to set to work again actively, to enable new large mines to be found, and particularly to organise and equip the smaller ones which are already known, so as to make them effectively productive. Everything points to money well laid out in such work reaping a very productive harvest.

The 883 small mines not held by registered companies produced in 1909 nearly £1,100,000 worth of gold, or a little over an average of £1,200 apiece. It is a very conspicuous feature of Western Australian mining, and one which counts very strongly in its favour, that there is such a large number of small parties of men working their own mines in a small way and making a living—and often very good profits as well—out of the ground by their own labour. So long as they are in the softer superficial country above the water level they can generally work without machinery at all, provided they are within accessible distance of a battery to which they can cart their quartz for treatment. In some respects this facility is really detrimental, for men take out the easily-got ore from near surface and then pass on to another reef, and in a few years the old workings become inaccessible. There is before me a little book published by our Mines Department showing a very long list of leases, 2,268 in all, which have become cancelled, and were in March, 1910, open for anyone to select. Many of them, however, are the same, or nearly the same, ground taken up two or three times over, first by one party then by another. The aggregate yield from these leases is a very large amount, every lease on the list having a recorded output of gold. I doubt if there is any place in the world which offers the man anxious to get a small mine of his own a better chance than Western Australia, for there is any amount of ground open for prospecting, and in most of the older districts there are facilities for crushing the ore within reasonable distance. Cartage is easy, almost anywhere, without having to spend much money in making and clearing roads. Many men, therefore, have made a very good living at working mines for themselves, and quite a number have made fortunes, without ever approaching the market. A prominent instance recently is that of the Fenian Mine at Meekatharra, owned by four men. It is opened up to a depth of 625 feet, has its own battery, cyanide plant, and winding machinery, and when I left the State was putting up new plant out of revenue. It has paid £77,000 in dividends, and the lucky owners were said to be getting dividends of £2,000 a month. Few have been so successful as this, but many other working parties have done very well. Very many such parties are now getting a fair amount of plant upon their mines and settling down to steady work, though very often better organisation and management than their own would make the mines far more profitable, the parties being often anything but good business men.

and frequently very indifferently skilled as miners. When a mine gets to the stage of being systematically worked with the aid of machinery, it is probably best in the majority of cases that it should be handled by a company under a skilled mining manager and not by private owners.

As we have now seen that there is nothing in the reproach that the people of Western Australia are themselves inactive in opening up their mines, let us examine another objection which is constantly being brought forward as a reason why the British investor should pass Australia by and put his money into foreign countries, namely, the alleged fact that the conditions of tenure of mining property are very onerous and unsatisfactory in the former. When one asks for instances and specific complaints, it is very soon found that the statement is based on misconceptions and misunderstandings of the true position made by people who do not understand—and often appear not to want to understand—the facts of the case. It would take far too long now to make a comparison of the terms offered to investors in mining properties by the various countries which are inviting the aid of British and European capital, but when the matter is closely gone into, any unbiassed investigator soon finds that there are few, if any, countries—personally, I have not been able to find any—which give terms more favourable to the investor than Western Australia. The whole tendency of recent legislation has been to make them still more favourable, it being thoroughly well recognised by all responsible political parties in the State that outside capital is required for active development of mining, and that good terms must be offered to attract it. Most of the complaints which have come within my own official knowledge have come from persons who have been trying to secure concessions and advantages to which they were not entitled, and who in many cases have been trying to evade their own performance of the obligations into which they entered when they undertook to work the mines. Such people often make a great outcry and present a fair-seeming *ex parte* case, but their statements should not be accepted as gospel until the other side has been heard in reply.

In 1907 and 1908 an investigation of the mining laws of Australia and New Zealand was carried out by a Special Commissioner, Mr. A. C. Veatch, sent from the United States Geological Survey at the instance of an Investigating Committee of Congress, whose report has been issued in Bulletin form by the Washington Government Printing Office. This gentleman speaks very highly of the mining laws of the Commonwealth, and is especially complimentary to those of Western Australia. He strongly favours the leasehold tenure obtaining there rather than the freehold one of the United States, and concludes by saying that:—"In short, viewed from the standpoint of present-day knowledge, the Western Australian mining law has proved a decided success." He elsewhere describes it as a "wonderfully symmetrical and carefully-balanced enactment," which as recently as 1904 has been revised "to meet the practical workaday conditions of a mining region."

Many of the objections urged against the mining laws of Australia arise from confusion of ideas as to the principles adopted by various countries. A person accustomed to freehold tenure is apt to misunderstand the laws of another country wherein, as in Australia, only a lease is granted of mineral ground, and the fee-simple is reserved to the State. There is much to be said for both principles of tenure, each having its own advantages and disadvantages, but, from the point of view of practical mining business, there does not seem to be much to choose between them so long as a mine is in active operation. It is when a man wishes to hold ground locked up for speculative purposes, or sometimes for protection of previous expenditure, that the freehold becomes most desirable; but for all working purposes the matter usually in practice is one of indifference, there being rarely any difficulty under the leasehold system in obtaining all reasonable protection of any owners' interests.

Objections are often raised in quibbling fashion to the powers left in the hands of the administration of the mining laws to decide when concessions may be made to leaseholders in such matters as total or partial exemption from working their ground for a time, terms on which labour may be concentrated on one portion of a holding, and similar matters, it being complained that the investor is too much at the mercy of the Government of the day. There is very little force in this argument. Most of the conditions governing such cases are, as far as possible, clearly prescribed by law, and, therefore, fixed and open to the knowledge of everybody, and where discretion is left to the administration, it is nearly always to meet the cases where special circumstances may require

special treatment, and the decision cannot be made by hard-and-fast rules, but must be left to the discretion of some person. Such cases are inevitable and protean, as in all other sorts of business. In dealing with people of one's own blood and language, one can surely look for reasonable consideration of questions in which both parties are jointly interested, and just treatment from local authority. Fears as to ultra-democratic legislation are on much the same footing; after all, the people in the colonies are very much like those in the parent country, with similar notions of fair dealing and justice, and no more to be feared than their relatives in the United Kingdom. As a matter of fact, no Government of any party in any Australian State has ever yet refused to consider reasonable representations of investors and to meet them in a reasonable spirit, and in a world of business it is surely clear that fair dealing all round must be the basis of conduct, no matter what party may occupy the seats of Government.

When trying to find out lately what it was that the London market has against Western Australia, I was rather surprised to find that a great complaint was that the Government did nothing to encourage investors to go there, and was asked what did we do to encourage any person to attempt to open mines in our State. Well, a great deal has been done and is being done towards that end. First of all, as just explained, we offer exceptionally favourable terms on which to acquire mining properties, and follow British principles of law, justice, and procedure in settling all disputes. If we offer good propositions, what more can anyone want than a thoroughly fair chance of trying them, and a fair run for his money under the conditions which exist when he undertakes the venture? But the Western Australian Government is all the time improving these conditions, as far as it is able, by spending large sums annually in building railways, establishing mail and telegraph services and other business facilities, providing water supplies, establishing State batteries at which preliminary trials may be made, assisting in diamond drilling, and even by direct monetary grants in some cases. The question is not what do they do to assist the investor, but what do they not do that is reasonable and feasible? The railway system comprised to June 30th, 1910, no less than 2,145 miles of line, costing £11,384,000 for construction and equipment, and is being constantly extended. During 1907–8, 102 miles of new line were opened, the next year 101 miles, and last year 100 miles. Since last June the railway to Black Range has been opened, also one from Nannine to Meekatharra, and three others are expected to be opened before the end of the financial year in June next. Others are projected, and on some of them work has been already begun, as in the case of the line from Port Hedland to Marble Bar, to open up the Pilbara goldfield. These lately-undertaken railways are practically all for developmental purposes; they have not been made because it was a payable business to do so, but in advance of settlement and development, in order to improve transportation so much that development could be greatly extended. Take, for example, the Port Hedland to Marble Bar railway. It would be idle to expect it to pay its way if the amount of work done in the district opened by it and the number of people in it were to remain as at present. But it is believed that the district is a good one and capable of great expansion of mining and population, if its present inaccessibility is removed, and there has been little hesitation in authorising the construction of the line once Parliament was convinced that this was the case. In the same way agricultural railways are being run out into nearly virgin country, to enable settlement to go on. Of course it is essential that as far as possible such work should be made immediately reproductive to try to cover working expenses and at least part of the interest bill, and while the volume of business is small, it is clear that somewhat high rates of freight may have to be charged. From time to time they are reduced as it becomes practicable to do so.

So also with water supply. The great pipe line, 351 miles long, which supplies the Kalgoorlie mines with water from near the coast, has cost £3,236,232, and though working expenses amount to only about 1*s.* 6*d.* per 1,000 gallons, averaging the whole system, interest and redemption bring the actual cost of the water sold last year to an average of 7*s.* 7*d.* per 1,000 gallons, and the full cost on the goldfields is estimated at 9*s.* 1½*d.* per 1,000 gallons. Water is sold to the mines at prices of from 4*s.* 9*d.* at Southern Cross to 8*s.* 6*d.* at Bulong per 1,000 gallons, where use is made of no other source of supply, the large mines at Kalgoorlie paying 7*s.* per 1,000 gallons, and a concession being made to poor mines by letting them have it at from 3*s.* 6*d.* to 5*s.* per 1,000 gallons. It is all very fine to grumble at the high rates of freight paid on some of the railways and the high cost

of water, but surely the Government have conferred a great benefit in making the services available, even at these so-called high rates. They are far lower than those previously prevailing when there was no railway and no pipe-line. Plainly, the Government have given immense assistance to mining by its railways and water-supply expenditure, and while these services are not yet making profits which would be considered commercially satisfactory, and are in many cases hardly, if at all, paying actual working expenses, it is surely somewhat ungrateful and ungracious to demand still further concessions from the Government.

Besides the Coolgardie water scheme, there is large Government expenditure in making and maintaining wells and tanks throughout the State, and all the main roadways are now fairly well provided with water. Boring parties are at once sent out to every new field which promises at all well, to try to find fresh water and battery-water supplies. The costs of established water stations during 1908, including interest and redemption, were £19,879, and the revenue was £12,634. The assistance given by the Government to mining in undertaking the water supplies is incalculably valuable.

The assistance given by the State battery system does not appeal so much to an investor in public companies as to the man who is trying to open a mine by his own work. To such they have been an inestimable boon, enabling them to pay their way out of the stone which they raise. During 1909 there were thirty-five batteries in operation, containing 294 stamps capable of crushing 300,000 tons of ore per annum, but, as they were not kept fully employed, only 94,218 tons were actually crushed. Most of these batteries have cyanide vats for leaching treatment of the tailings, and some have been equipped with slimes treatment plant as well. From the inception of the system to end of 1909 the State batteries have cost £275,320, and have crushed 695,129 tons of gold ore, averaging a yield of 1·04 ozs. of unrefined gold per ton, for a return of £2,658,966. They have also treated 449,492 tons of tailings (sands and slimes) for a return of £42,192, bringing the total value of gold extracted to £2,701,158. The tonnage is mostly in small parcels, the batteries in 1909 treating, for example, 1,741 separate lots, or an average of fifty-four tons per lot. From its inception to the end of 1909 the loss on the State battery system is stated as £105,411, or, including depreciation, £257,787. Though this is a large sum for the Government to have spent to assist in the opening up of the fields, it has, without doubt, been more remunerative than the figures would indicate, for the existence of the State mills has been the means of keeping many districts alive that would otherwise have been abandoned, and has so developed others—such as Black Range, Meekatharra, and others—that they have reached the stage when many of the mines have mills of their own, and some of them have been taken over by public companies.

Besides the State batteries, owned and worked directly by the Mines Department, there are many privately-owned batteries throughout the State which receive subsidies from the Government to induce them to throw their doors open for crushing for the public. During 1909 there were twenty-nine such batteries subsidised, which crushed 30,767 tons of ore. The average rate of subsidy was 1*s.* 5½*d.* per ton, the rates varying greatly according to locality. This represented direct assistance from the Treasury of £2,207.

Under the Mining Development Act loans, at a rate not exceeding £1 for £1 of their own expenditure, are made to parties working mines to assist them in developing their mines and equipping them with machinery, the loans being repayable if the mine proves successful, and being secured by mortgages upon the mine and plant. Advances on similar but somewhat less stringent terms may also be made to persons putting up mills for public crushing purposes. Money may also be advanced on loan for boring with diamond and other drills, or may be expended by the Government on its own account, and subsidies are often granted to people who have to cart trial parcels of ore long distances, and also to prospecting parties which are developing their mines below a depth of 100 feet from the surface. Assistance is also given to prospectors in approved cases by providing them with Government camels, or horses and carts, to enable them to open up new country. The total expenditure for 1909 for these purposes was £13,896, and refunds were obtained to the amount of £2,430. The principal and accrued interest on outstanding loans at the end of 1909 was £28,479, and £11,976 had been written off as irrecoverable.

The aid of scientific investigation of the mines and mineral fields is not overlooked either, for an active geological survey is maintained, and also a well-equipped school of mines, both involving large annual expense.

In fact, all along the policy of the Western Australian Government has been to encourage mining by every means in its power, and it has expended, and is expending, very large sums of money in doing so.

It is, therefore, quite incorrect to say that the Western Australian Government does little or nothing to encourage and assist the mining industry, and one might think our grumbling objector would at last be silent; but, no, he has still a heavy shot in his locker. This time he cries that West Australian mines are no good any way, as the gold does not "go down" and the mines are of no value in depth, and he points to numbers of mines in proof of his statement in which the values have been soon lost. To demonstrate that it is quite an unwarrantable generalisation to infer that all will behave in the same way is hardly possible, without going into numerous geological and genetic considerations which would take too long to discuss at present, and the conclusion would depend very much upon the interpretation which should be placed upon the facts of the cases. In many instances the facts have been incorrectly or inadequately stated, often through want of acquaintance of the operators with points in the behaviour of the lodes which have an obvious and important significance in the eyes of a student of ore deposits, but which may entirely escape the observer—even a highly-skilled and practical man otherwise—who has not studied the scientific side of the business and trained himself to notice occurrences which may not appear to have any connection with the exploitation of the ore, but from which important deductions may be drawn by those who can refer effects back to the causes which have brought them about. It has rarely been recognised, for example, that it appears to be a very common feature of many West Australian ore bodies that they have been disrupted, by earth movements or faulting, along the planes of the lodes themselves, these movements subsequent to the formation of the ore bodies having re-opened the old line of fracture in which the lode was first formed. The good stone is often found suddenly to "cut out"—a term always highly suggestive of some form of faulting—and, as a rule, little search is then made to recover it. Frequently there is a reef of poor or barren quartz present alongside the valuable one, which is of later date of formation than the latter, and which is left standing while the good ore is taken out, but it is uncommon to find any rational deduction being made from the fact that such a condition is *prima facie* evidence that there was a re-opening of the old reef fissure to enable the later poor reef to be formed, and that in the course of the faulting movement which would result, the older reef would almost certainly become much broken and displaced. When it disappears suddenly and the poor reef continues, it is quite usual to assume that the two have joined one another and that the values are simply vanished, instead of search being made for the dislocated continuation of the good ore. It is not contended that this explanation applies to all or even to the most important cases of loss of values in the lodes, but many instances of it have come under my own observation, and there is a good deal of reason to think that many cases of curious separation of lenses of ore containing values may really be explainable by the faulting of an originally continuous body. In dealing with these lodes we are probably handling the case of deposits formed in very early geological times, during a period of much earth movement and plication of the region containing the mines, and therefore particularly liable to show much dislocation of the contained ore veins.

Another characteristic feature of the lodes of Western Australia is the unusual amount of secondary enrichment which appears to have gone on in most of them near the surface, especially in the zone of oxidation above the water level. This has often led to much disappointment when the deeper parts of the lodes have been reached, but it is a feature which is now becoming much better understood than formerly, and for which allowance is to be made. There is, however, much doubt yet as to the depth below surface to which its effects are perceptible.

In some cases the values disappear so suddenly at the water level that there is a temptation to speculate on the possibility of their having been removed by leaching upwards, there being a certain amount of constant drawing upwards of the ground-water by capillarity to replace the moisture removed by surface vegetation and evaporation. In an arid climate this action may be expected to be more marked than in a humid one. The possibility seems sufficiently feasible to require some sinking to be done in such cases in order to pass through what may be not an enriched but an impoverished zone.

As a matter of fact, good values have been found in Western Australian mines at the greatest depths to which mining has been

carried, namely, the 2,650 feet level of the Great Boulder Mine. So far as work has gone at that level, it is true that values have not been so satisfactory as at the 2,500 feet level, and there has been much fear expressed in consequence that this famous mine was at last failing. But some good ore has been obtained, and it must be remembered that at all the levels it has been often easy to miss the best ground until a great deal of exploration has been done. The following of ore in the Western Australian mines is anything but a simple proposition, the ore often being hidden behind what are apparently the well-defined "walls" of the reef, while the lode stuff between these is of little or no value. In almost all the mines of Kalgoorlie it has been found essential to do a great deal of boring across the strike of the reef to locate hidden ore, and the first drive along the lode has often been anything but a true test of its value. This local peculiarity must be recognised and allowed for, and time given to open the ground pretty thoroughly before jumping to conclusions about extinction of values. The whole history of the Boulder Mines from below the oxidised zone has shown a succession of pessimistic forecasts of their early decease, and from time to time the prospects of first one and then another of them have appeared very doubtful. Time and again, however, further exploration has brought about new developments and the position has improved, and there is therefore always much hope that perseverance will be well rewarded. All the principal mines show much more variation in their values at different points than is generally understood by the public, and it is owing to this feature of them that it is so difficult—indeed, almost impossible, in many cases—to make really reliable estimates of ore reserves. The only safe course is to keep the mining development a long way ahead of the ore-breaking, to give time for fresh ore bodies to be picked up before the older ones are worked out.

It is undeniable that in Western Australia, as in all other parts of the world, the lower levels of the mines have not been so productive as those nearer the surface, but it does not seem to me that in this respect they have shown any more lack of permanency in depth than those of most other mining fields, nor is there any satisfactory reason yet apparent why values should not be found to persist in them to quite as great depths as in any other mining region, say, to 4,500 feet as in Bendigo, or even to the immense depth of 6,000 feet at which mining in South Africa has been seriously contemplated. The grounds on which early extinction of values has often been predicted are mainly quite theoretical, and, notwithstanding that great advances have been made towards formulating a science of ore deposits, it cannot be denied that there is still very great conflict of opinion among the best authorities on the subject on the most fundamental propositions as to the mode and conditions of ore formation. For example, not very long ago a discussion was published as to the origin of a certain pyritic ore body, in which one leading authority held the view that it had been formed by magmatic differentiation from an igneous mass, another that it was an ordinary lode of hydrothermal or pneumatolytic origin, and a third that it was a metamorphic sedimentary deposit, all radically different and incompatible conceptions. While one school of opinion regards ore deposits as more or less chemical concentrations from the more superficial rocks of the earth's crust, due to circulation of liquid solutions through them, and another holds equally strongly that they arise mainly from emanations from plutonic sources, there cannot be said to be any accepted theory of ore formation on which it is safe to build practical conclusions as to behaviour of lodes in depth. The various hypotheses may be useful to guide exploration, but the only practical course is to sink down to see what the ground will show. This has been the mining maxim from its earliest days, and it is still as necessary as ever. No theory is yet so firmly established as to justify deductions being made from it without the check of actual trial.

A great deal of the fear that is expressed as to permanency of ore deposits in depth is often founded on what is really an entirely unproved assumption, though it has a certain amount of *prima facie* probability, namely, that in a deposit formed by ascending hot waters the metals would be likely to be in solution in the deeper zones while at high temperature and under high pressure, and would only be deposited as in ascending through the crust of the earth the temperature and pressure are reduced and the solutions come in contact with more superficial waters carrying precipitants. It is somewhat inconsistent that this view should be put forward as a reason for expecting falling off in value in reefs like those of northern New Zealand, which seem plainly to be of hydrothermal origin and outcropping probably at no great depth below the original outlets of the hot springs which formed them, and also for the pneumato-genetic

lodes of Kalgoorlie, the portions of which now accessible to us have most probably been formed at great depths under pneumatolytic rather than hydrothermal conditions. And when we come to consider the case of the gold-bearing alaskites, where we seem to be dealing with a transition stage between plutonic dykes and ordinary reefs, it is difficult to understand that either temperature or pressure can necessarily be the determining factors of deposition which they have often been assumed to be.

It seems to me that the mining industry has a right to protest against the very unscientific attitude taken by some persons claiming to be authorities who have allowed themselves to be carried away by deductions from the theories which they adopt with regard to ore deposition, and issued dogmatic statements as to what *must* happen to ore deposits in depth. In the present state of the science any such views can only be tentative, and should be clearly understood to be so. They carry more weight with the investing public than ought to be allowed to them, views which are the mere speculations of an authority being often taken to represent the demonstrated conclusions of science, and in consequence exploratory work which would be undertaken if these ideas had not been put forward may be restricted or abandoned, to the great detriment of mining.

To conclude this long address, I would wish to draw attention again to the exceptionally good opportunities offered by Western Australia to capital for legitimate mining operations, and also to men who have to depend on their own physical efforts to make their living for doing so either in mining or in farming pursuits. There is a great field for enterprising and steady young men who would learn the business of prospecting and working small mines, so as to be able to become their own masters and get mines of their own. Taking the various fields there is ample choice of districts. In the north the Kimberley goldfield is and has been for years past lying practically deserted, largely on account of the difficulties of transport and consequent high cost of all necessaries of life and industry. West of it there have been discoveries of copper ore, mostly rather inaccessible just now, gold, and wolfram; and on the coast alongside deep water at Yampi Sound there is a huge deposit of excellent iron ore which must before long be utilised. In the Pilbara goldfield, which is being now opened by a railway, there are gold, copper, antimony, tin and asbestos deposits, also monazite and diamonds. West Pilbara has copper, gold and antimony, and deserves much more attention than it has yet had accorded to it. In the Ashburton and Gascoyne fields there are copper and lead deposits, as well as gold, and the occurrence of coal measures gives expectation that coal may be found. All these fields which I have yet mentioned are very little opened up by mining, though minerals are well distributed through them, but are mostly taken up by pastoralists in extensive sheep, cattle and horse stations. In the Peak Hill and Murchison fields there is much stagnation at some of the older centres, but new discoveries are often made, and two good new districts—Meekatharra and Black Range—have come very much to the front of late years as gold producers. The Youanme district is also promising very well. At several points in the Murchison field there are lodes carrying copper ores, and there is one small tin-field lately discovered. West of the Murchison lies the old Northampton district, which has produced about £365,000 worth of lead ore, and £149,000 of copper ore, mostly before the goldfields of the State were discovered. Low prices for the metals and high costs of transport were the principal causes of this field being abandoned, and, being largely private property, there have been difficulties in the way of later prospectors obtaining access to much of it. The Yalgoo field south of the Murchison has had little production, but has several localities worth attention. The East Murchison and Mount Margaret fields have a large number of auriferous centres, and are anything but thoroughly prospected yet, while they contain dozens of partly-tried mines which deserve more opening up. The same may be said of the others of the eastern goldfields. The recent successes of prospecting operations on the Southern Cross belt are only an earnest of what may reasonably be expected from resumption of systematic prospecting elsewhere through the fields. The Bullfinch discovery early in the present year is within eight miles of the Golden Valley, at which the first gold was found in the eastern goldfields in 1887 and quite close to the track from there to the next discovery at Southern Cross. The Corinthian leases, some seven or eight miles further south, are likewise close to the road travelled by hundreds of prospectors for the last twenty-three years, but were not found till last year. Yet the lode forms strong outcrops of quartz which would attract the attention of any prospector. The fact that the surrounding country is lake flats possibly misled prospectors into thinking that

there were no outcrops to be found, low hills being quite imperceptible when one is travelling through wooded country. A great deal of prospecting could be advantageously carried on in many of the lake flats throughout the State, as many lodes are certainly covered and do not appear at surface at all. A few have been found here and there as at Lake Darlot and Comet Vale, but as a general rule very little has been done in the flats to look for lodes.

The southernmost field of all, that of Phillips River, contains gold and copper, and is the scene of the large enterprise of the Phillips River Gold and Copper Company, as well as of several smaller local mines. It was at first very inaccessible, and it is still rather likely to be a trying experience to visit it either by land or water, but a good deal has been done to render landing easier at Hopetoun, and a railway has been made thence to the main town of the district—Ravensthorpe.

There is still much unexplored country in Western Australia to attract adventurous people who desire to look for entirely new fields, and it is very possible that such may be found. At the present moment the feeling in the State is rather that it is advisable to prospect further the known fields than to go off into places in which it would be difficult to work profitably any discoveries that might be made, on account of their distance from formed lines of communication.

APPENDIX.

STATISTICAL DATA RELATING TO THE MINERAL INDUSTRY OF WESTERN AUSTRALIA.

Area of Western Australia ... ... 975,920 square miles

„ Proclaimed Goldfields ... ... 330,126 „ „

Leases in force 1909 numbered 2,105, comprising ... ... 28,919 acres, or over 45 square miles

Number of stamps employed 1909 3,572

Population of the State, June, 1910 282,124

Number of men employed in Mining—

1905	1906	1907	1908	1909
19,342	19,429	19,113	17,266	18,336

Miners' Rights issued—

1907	1908	1909
7,163	7,030	6,032

Total production of Gold to end of 1909 ... ... 21,606,968 fine ounces, equal to 661·4 tons of value £91,780,565

1 *ton Fine Gold* (2,240 *lbs. avoirdupois*) *comprises* 32,666⅔ *ounces Troy of value* £138,759·1.

1 *oz. Fine Gold is worth* £4·24773.

TABLE No. 1.

GOLD AND MINERAL PRODUCTION OF WESTERN AUSTRALIA.

According to Royal Mint Returns, and Returns of Exports of Gold and Minerals, together with Mineowners' Returns of Coal, Limestone, and Ironstone Locally Produced.

YEAR.	GOLD. Fine ozs.	GOLD. Value.	SILVER. Value.	COPPER. Value.	TIN. Value.	Lead, Silver Lead and Pig Lead. Value.	COAL.—Value Local Production Returns.	COAL.—Value Exported.	Limestone and Ironstone (Local Production Returns).	Other Minerals. Value.	TOTAL VALUE.
		£*	£	£	£	£	£	£	£	£	£
Prior to 1886	...	...	...	127,132	...	357,097	...	...	...	...	484,229
1886	270·17	1,148	...	3,735	...	4,277	...	...	...	...	9,160
1887	4,359·37	18,517	...	345	...	4,830	...	...	...	...	23,692
1888	3,124·82	13,273	...	1,488	...	5,360	...	...	...	...	20,121
1889	13,859·52	58,872	...	1,904	300	2,500	...	...	...	...	63,576
1890	20,402·42	86,664	...	136	5,400	2,135	...	...	...	...	94,335
1891	27,116·14	115,182	...	4,462	10,200	250	...	...	...	...	130,094
1892	53,271·65	226,284	...	8,696	13,843	150	...	...	...	25	248,998
1893	99,202·50	421,385	...	606	11,134	...	...	...	...	4	433,129
1894	185,298·73	787,099	...	...	15,274	...	...	...	...	...	802,373
1895	207,110·20	879,748	...	12,952	9,703	...	...	...	...	3	902,406
1896	251,618·69	1,068,808	...	100	4,338	...	...	...	...	...	1,073,246
1897	603,846·44	2,564,977	...	1,033	3,275	15	...	...	...	209	2,569,509
1898	939,489·49	3,990,698	...	4,266	2,760	33	1,761*	1	300*	...	3,997,758
1899	1,470,604·66	6,246,732	...	41,452	23,163	1,173	25,951	772	11,777	51	6,313,343
1900	1,414,310·86	6,007,611	3,594	33,937	57,050	242	54,835	350	12,852	88	6,102,872
1901	1,703,416·52	7,235,653	7,609	110,769	52,102	...	68,561	969	17,594	4	7,407,106
1902	1,871,037·35	7,947,661	9,190	12,904	39,398	...	86,188	12	3,380	47	8,009,212
1903	2,064,801·40	8,770,719	19,153	37,815	52,133	...	69,128	127	266	240	8,880,187
1904	1,983,230·07	8,424,226	45,912	7,859	43,273	...	67,174	7	2,276	81	8,521,358
1905	1,955,315·88	8,305,654	44,278	65,251	76,779	...	55,312	87	2,505	5,856	8,497,905
1906	1,794,546·60	7,622,749	37,612	36,529	147,380	...	57,998	65	2,203	1,035	7,845,370
1907	1,697,553·59	7,210,749	25,382	203,376	166,139	1,866	55,158	1,166	1,820	4,977	7,613,655
1908	1,647,911·13	6,999,882	18,877	57,091	83,595	5,006	75,694	7,758	...	4,500	7,176,709
1909	1,595,269·41	6,776,274	18,778	104,644	65,959	1,199	90,965	93,964	...	1,079	7,061,897
TOTAL	21,606,967·61	91,780,565	230,385	878,482	883,198	386,133	708,725	105,278		18,199	94,282,240
							†603,447		†54,973		†658,420
											£94,940,660

Not including columns marked * (Total Value, 1898–1909).

* Previous to 1899. † Local Consumption.

This table differs from Published Summary by £501, being difference of Asbestos Reported £1,754, and Exported £1,253.

TABLE NO. 2.

WORLD'S GOLD PRODUCTION, 1897 to 1908.

YEAR.	World's Production of Gold.	Gold Produced in Commonwealth.	Percentage of Commonwealth on Total.
	£	£	Percentage.
1897	48,196,000	9,890,000	20·52
1898	58,136,000	11,679,000	20·09
1899	63,015,000	14,533,000	23·06
1900	51,515,000	13,578,000	26·36
1901	53,544,000	14,006,000	26·16
1902	60,869,000	14,812,000	24·33
1903	66,650,000	16,295,000	24·45
1904	70,688,000	15,897,000	22·49
1905	76,675,000	15,551,000	20·28
1906	82,569,000	14,632,000	17·72
1907	84,904,000	13,515,000	15·92
1908*	91,450,000	13,059,000	14·28

* Partly estimated.

TABLE NO. 3.

INCREASE IN GOLD YIELD, VARIOUS COUNTRIES, 1897 to 1908.

COUNTRY.	1897.	1900.	1903.	1907.	1908.*
	£	£	£	£	£
United States	11,787,000	16,269,000	15,122,000	18,583,000	19,566,000
Canada	1,240,000	5,742,000	3,877,000	1,725,000	2,025,000
Mexico	2,045,000	1,122,000	2,197,000	3,733,000	4,137,000
Transvaal	11,654,000	1,481,000	12,628,000	27,401,000	29,973,000
Rhodesia	800	308,000	828,000	2,179,000	2,526,000
Gold Coast	85,000	38,000	255,000	1,164,000	1,195,000
Madagascar	8,500	142,000	232,000	267,000	345,000
India	1,571,000	1,893,000	2,303,000	2,133,000	2,097,000
Korea	208,000	371,000	557,000	471,000	480,000
Japan	142,000	290,000	428,000	401,000	659,000
Java	24,000	100,000	280,000	479,000	610,000
Costa Rica	2,000	14,000	7,000	70,000	122,000

* Partly estimated.

TABLE No. 4.

VALUE OF GOLD RAISED IN AUSTRALIA, 1851 to 1908.

YEAR.	N.S.W.	Victoria.	Queensland.	S.A.	W.A.	Tasmania.	C'wealth.
	£	£	£	£	£	£	£
1851.........	468,336	851,596	...	...	...	...	1,319,932
1852.........	2,660,946	9,146,140	...	...	...	...	11,807,086
1853.........	1,781,172	10,976,392	...	...	...	...	12,757,564
1854.........	773,209	8,873,932	...	...	...	...	9,647,141
1855.........	654,594	11,277,152	...	...	...	...	11,931,746
1856.........	689,174	12,214,976	...	8,800	...	...	12,912,950
1857.........	674,477	11,320,852	...	876	...	...	11,996,205
1858.........	1,104,175	10,384,924	...	2,348	...	...	11,491,447
1859.........	1,259,127	9,394,812	...	730	...	...	10,654,669
1860.........	1,465,373	8,896,276	11,631	...	...	...	10,373,280
1861.........	1,806,171	8,140,692	3,137	...	...	...	9,950,000
1862.........	2,467,780	6,920,804	499	12,442	...	...	9,401,525
1863.........	1,796,170	6,779,276	11,820	...	...	...	8,587,266
1864.........	2,304,926	6,489,788	66,513	...	...	...	7,861,227
1865.........	1,231,243	6,446,216	74,216	...	...	...	7,751,675
1866.........	1,116,404	6,187,792	68,325	...	...	...	7,372,521
1867.........	1,053,578	6,005,784	151,125	...	...	4,382	7,214,869
1868.........	994,665	6,739,672	473,956	2,936	...	2,536	8,213,765
1869.........	974,149	6,179,024	417,681	15,593	...	514	7,586,961
1870.........	931,016	5,217,216	390,925	24,217	...	7,475	6,570,849
1871.........	1,250,485	5,475,768	492,635	6,000	...	14,218	7,239,106
1872.........	1,644,177	5,325,508	527,365	6,363	...	16,055	7,519,468
1873.........	1,396,375	4,681,588	572,996	293	...	18,390	6,669,642
1874.........	1,041,614	4,390,572	1,082,899	4,175	...	18,491	6,537,751
1875.........	877,694	4,273,668	1,196,583	7,034	...	11,982	6,366,961
1876.........	613,190	3,855,040	1,140,282	9,888	...	44,923	5,663,323
1877.........	471,448	3,238,612	1,043,780	...	...	23,289	4,777,129
1878.........	430,200	3,032,160	1,149,240	1,225	...	100,000	4,712,825
1879.........	407,219	3,035,788	1,034,216	90	...	230,895	4,708,208
1880.........	444,253	3,316,484	944,869	...	...	201,297	4,906,903
1881.........	573,582	3,333,512	957,570	112,825	...	216,901	5,194,390
1882.........	526,522	3,458,440	785,868	85,354	...	187,337	5,043,521
1883.........	458,530	3,121,012	736,810	87,729	...	176,442	4,580,523
1884.........	396,059	3,114,472	1,062,471	93,404	...	160,404	4,826,810
1885.........	378,665	2,940,872	1,062,514	88,709	...	155,309	4,626,069
1886.........	366,294	2,660,784	1,187,189	95,674	1,148	117,250	4,428,339
1887.........	394,579	2,471,004	1,481,990	140,777	18,517	158,533	4,665,400
1888.........	317,241	2,500,104	1,690,477	69,007	13,273	147,154	4,737,256
1889.........	434,784	2,459,352	2,695,629	84,956	58,871	119,703	5,853,295
1890.........	460,285	2,354,240	2,182,563	101,577	86,664	75,888	5,261,217
1891.........	559,231	2,305,596	2,030,312	126,081	115,182	145,459	5,281,861
1892.........	575,299	2,617,824	2,164,391	135,755	226,284	158,917	5,878,470
1893.........	651,286	2,684,504	2,167,794	120,691	421,385	141,326	6,186,986
1894.........	1,156,717	2,867,816	2,330,282	143,100	787,099	217,024	7,502,038
1895.........	1,315,929	2,960,344	2,150,561	128,876	879,748	206,115	7,641,573
1896.........	1,073,360	3,220,348	2,132,979	95,560	1,068,808	237,574	7,828,629
1897.........	1,104,315	3,251,064	2,552,668	120,230	2,564,977	296,660	9,889,914
1898.........	1,201,743	3,349,028	2,750,348	95,465	3,990,698	291,496	11,678,778
1899.........	1,623,320	3,418,000	2,838,446	79,147	6,246,732	327,545	14,533,190
1900.........	1,070,920	3,229,628	2,871,578	82,482	6,007,610	316,220	13,578,438
1901.........	737,164	3,102,753	2,541,764	93,222	7,235,653	295,176	14,005,732
1902.........	684,970	3,062,028	2,720,512	95,203	7,947,662	301,573	14,811,948
1903.........	1,080,029	3,259,482	2,839,801	90,250	8,770,719	254,403	16,294,684
1904.........	1,146,109	3,252,045	2,714,934	80,008	8,424,226	280,015	15,897,337
1905.........	1,165,013	3,173,744	2,517,295	76,824	8,305,654	312,380	15,550,910
1906.........	1,078,866	3,280,478	2,313,464	81,225	7,622,749	254,963	14,631,745
1907.........	1,050,730	2,954,617	1,978,938	42,468	7,210,749	277,607	13,515,109
1908.........	954,854	2,849,838	1,963,315	36,243	6,999,882	242,482	13,046,614
Total £......	56,319,736	282,321,433	68,277,156	2,785,852	85,004,290	6,766,303	501,474,770

TABLE No. 5.

AUSTRALASIAN MINERAL PRODUCTION (All Minerals). 1902-1909.

YEAR.	Western Australia.	New South Wales.	Queensland.	Victoria.	Tasmania.	South Australia.	New Zealand.
	£	£	£	£	£	£	£
1902	8,094,617	5,242,342	3,310,600	3,284,008	1,498,283	576,374	3,221,622
1903	8,971,937	6,059,486	3,686,096	3,326,520	1,466,714	572,960	3,041,466
1904	8,623,587	6,402,558	3,704,262	3,332,898	1,411,192	595,751	2,884,774
1905	8,555,841	7,017,940	3,726,275	3,268,982	1,729,129	536,803	3,015,685
1906	7,975,647	8,169,624	4,198,647	3,382,285	2,257,147	977,164	3,297,731
1907	7,640,153	10,577,378	4,134,686	3,066,585	2,277,159	913,863	2,349,236
1908	7,243,349	8,609,607	3,844,487	2,939,344	1,647,569	457,900	2,282,499
1909	7,059,052	7,635,693	3,656,554	2,873,705	1,574,995	413,390	2,383,650
Total 8 yrs.	64,164,183	59,714,628	30,261,607	25,474,327	13,862,188	5,044,205	22,476,663
Average per annum.	8,020,523	7,464,329	3,782,701	3,184,291	1,732,774	630,526	2,809,583
Percentage of total.	29·0 %	27·0 %	13·7 %	11·5 %	6·3 %	2·3 %	10·2 %

GRAND TOTAL, 8 years £220,997,801

" " Annual Average £27,624,725

TABLE No. 6.

ESTIMATED VALUE OF PRODUCTION FROM INDUSTRIES, 1908.

STATE.	Agri-culture.	Pastoral.	Dairy, Poultry and Bee-farming.	Forestry and Fisheries.	Mining.	Manufacturing. (Val. added in process of manufacture.)	TOTAL.
	£1000	£1000	£1000	£1000	£1000	£1000	£1000
New South Wales.........	9,686	22,021	5,425	1,165	8,381	14,053	60,731
Victoria	12,922	6,223	5,346	715	2,963	11,723	39,892
Queensland..................	3,462	11,709	2,294	982	3,828	3,738	26,013
South Australia............	7,119	3,905	1,137	182	528	3,742	16,613
Western Australia.........	1,949	2,317	297	1,025	7,245	2,152	14,985
Tasmania	2,012	1,084	546	217	1,623	1,229	6,711
Commonwealth............	37,150	47,259	15,045	4,286	24,568	36,637	164,945

TABLE No. 7.

TABLE SHOWING RELATION OF MINERAL EXPORTS FROM WESTERN AUSTRALIA TO TOTAL EXPORTS.

YEAR.	Total Exports.	Mineral Exports (exclusive of Coal). Total.	Percentage.
	£	£	
1900	6,852,054	5,644,460	82·4
1901	8,515,623	6,920,118	81·3
1902	9,051,358	7,530,319	83·2
1903	10,324,732	8,727,060	84·5
1904	10,271,489	8,625,676	84·0
1905	9,871,019	7,731,954	78·3
1906	9,832,679	7,570,305	77·0
1907	9,904,860	7,544,992	76·1
1908	9,518,020	7,151,317	75·1
1909	8,860,494	5,906,673	66·7
10 Years	93,002,328	73,352,874	78·9

TABLE No. 8.

GOLD MINING DIVIDENDS IN WESTERN AUSTRALIA.

YEAR.	Production.	Dividends paid by Companies.	Dividends % of Total Production.	Production by Registered Companies only.	Dividends % upon Production by Registered Companies.
	£	£	Percentage.	£	Percentage.
Prior to 1902...	29,722,650	6,078,107	20·5		
1902	7,947,662	1,424,272	18·0		
1903	8,770,719	2,024,152	23·1		
1904	8,424,226	2,050,547	24·3		
1905	8,305,654	2,167,639	26·1		
1906	7,622,749	1,993,698	26·1		
1907	7,210,749	1,738,163	24·1	5,722,273	30·4
1908	6,999,882	1,487,317	21·2	5,503,784	27·0
1909	6,776,274	1,359,115	23·0	5,398,725	25·2
	91,780,565	20,323,010	22·1	16,624,782 (three last years only).	27·6 (three last years only).

TABLE NO. 9.

GOLD PRODUCTION OF WESTERN AUSTRALIA, 1907 to 1909.

Mines producing over 5,000 ozs. of Gold per annum.

1907.			1908.			1909.		
No. of Mines.	Ore treated. Tons.	Gold therefrom. Fine ounces.	No. of Mines.	Ore treated. Tons.	Gold therefrom. Fine ounces.	No. of Mines.	Ore treated. Tons.	Gold therefrom. Fine ounces.
40	2,429,242	1,262,557	40	2,474,173	1,211,722	42	2,556,654	1,224,548

Mines producing over 1,000 ozs. of Gold per annum.

Year.	Mines Privately Owned.		Mines Owned by Companies.		Total.	
	Districts.	No. of Mines.	Districts.	No. of Mines.	Districts.	No. of Mines.
1907	19	55	23	80	24	135
1908	18	44	21	73	22	117
1909	17	36	20	70	21	106

TABLE No. 9—(*continued*).

Goldfields.	Registered Companies producing over 12,000 ozs.						Registered Companies producing under 12,000 ozs.						Leases and Claims, exclusive of Sundry Parcels, Banks, &c.					
	1907.		1908.		1909.		1907.		1908.		1909.		1907.		1908.		1909.	
	No.	Fine Ounces.	No.	Fine Ounces.	No.	Fine Ounces.	No.	Fine Ounces.	No.	Fine Ounces.	No.	Fine Ounces.	No.	Fine Ounces.	No.	Fine Ounces.	No.	Fine Ounces.
Kimberley ...... Pilbara, West ... Pilbara	...	...	...	...	...	...	2	22	2	304	4	128	22	4,432	32	150	32	6,278
Peak Hill	...	...	...	...	...	...	2	7,414	2	7,200	2	7,136	6	573	8	582	6	664
East Murchison	2	25,360	5	99,324	4	97,632	13	42,660	10	19,619	8	33,986	99	45,523	88	21,419	109	19,670
Murchison	1	99,253	1	81,585	1	41,269	6	20,624	10	17,420	12	21,834	175	43,665	178	50,058	184	64,924
Yalgoo	...	...	...	...	...	...	5	1,765	...	...	2	629	6	2,579	10	544	12	1,175
Mount Margaret	3	102,499	4	100,741	4	107,252	11	27,616	9	17,268	11	16,876	110	36,937	66	33,083	66	28,193
North Coolgardie	...	...	...	...	...	...	19	31,210	21	42,572	18	35,657	144	39,615	143	42,785	149	37,592
Broad Arrow ...	...	...	...	...	...	...	9	10,860	5	5,296	3	2,352	41	11,046	46	13,133	45	14,770
North-East Coolgardie	...	...	...	...	...	...	8	17,438	7	15,804	9	14,781	46	10,796	40	7,394	44	7,803
East Coolgardie	11	849,922	13	802,220	13	811,789	37	43,843	30	30,449	31	31,120	72	24,741	70	28,776	69	36,673
Coolgardie	1	12,375	...	...	...	...	19	24,374	15	24,141	14	15,966	75	22,322	74	13,240	72	15,723
Yilgarn	...	...	...	...	...	...	6	12,807	5	9,744	5	10,526	24	6,039	34	9,779	40	8,312
Dundas	...	...	...	...	1	12,750	6	14,824	6	20,627	7	6,017	26	5,522	31	6,524	36	7,577
Phillips River ...	...	...	...	...	...	...	5	2,272	4	1,386	4	3,266	33	2,033	21	3,019	19	3,445
	18	1,089,409	23	1,083,869	23	1,070,693	148	257,727	126	211,831	130	200,274	879	255,825	841	230,484	883	252,798

DISCUSSION.

The CHAIRMAN said a letter had been received from Dr. Henry Woodward, F.R.S., and a telegram from Sir C. H. Rason. Dr. Woodward's letter expressed his regret at being unable to accept the invitation to be present, and Sir C. H. Rason's telegram ran as follows:—"Much regret prevented attending. I am sure Montgomery's able Paper will convince many that all the prizes of mining in Western Australia are not yet drawn." Continuing, the Chairman thought the paper read by Mr. Montgomery was very encouraging both to prospectors and people who had their money in mines which might not be so flourishing as they wished. The author evidently did not think there was any reason why, if some mines were carried deep enough, something worth having should not be found. The little note of warning he had given, namely, not to be too ready to put their money into schemes which were floated directly anything was started in the shape of a find, was practical and of great value. There must be a good many finds in a large undeveloped country, but there should be a little more searching investigation into them before the British public subscribed money for their development.

[At this stage of the proceedings Admiral Sir Frederick Bedford had to leave the meeting, and the Chair was taken for the remainder of the time by the Hon. John McCall, M.D., Agent-General for Tasmania.]

Mr. T. A. RICKARD said it gave him pleasure to unite with others in complimenting Mr. Montgomery on his comprehensive and most timely paper. His own knowledge of the conditions obtaining in Western Australia was sufficient to enable him to appreciate the sincerity of the author's effort to give the facts in an informing manner. The paper, of course, was full of suggestive ideas, some of which were open to discussion. He joined with the author in emphasising the relation of mineral discovery to human industry, and of industry to empire. The search for metallic wealth and the exploitation of mineral resources were associated in the minds of most people with dubious financial exercises and gambling of a variously intelligent character; but Britishers hardly appreciated enough the fact that their overseas dominions were the sequel to gold-seeking, that the prospector blazed the trail of empire, and that while trade followed the flag, it was the pick that preceded the flag. The pages of modern history showed that Canada, Australia, and Africa were won by those who penetrated the waste places of the earth in the search for gold and silver, lead and copper; self-interest prompted their quest, but they built better than they knew, for they laid the foundations of civilisation. That was, however, a subject too big for casual reference. The author had given an excellent summary of the physiographic conditions affecting life and work in Western Australia. It was a healthy country, and he could well advise our young men to go there. There was a time when dysentery and typhoid were rampant, twelve or fourteen years ago, during the period of greatest expansion, when the conditions of living were haphazard and rough. But now, thanks to railways and water systems, Western Australia was a country in which a man could make a home. The members would have appreciated the author's analysis of the gold production and his explanation of the relation between the winning of gold from the ground as against the extraction of gold from the pockets of the credulous and greedy. The distinction was one that was properly made by a State mining engineer, and it was one that the public would do well to understand. Unfortunately, the amount of gold produced and the number of dividends paid did not serve as a measure of the profit and loss made in mining, for the capital involved—he did not say invested—far exceeded that which was required to find and equip the mines. Statistics were only misleading, for they did not concern themselves either with the derelicts on which money had been vainly spent, or with the inflations to which in times of excitement the market value of mines was subjected. If the author had been able to ascertain the total capital spent, not on the ground alone, but in London, in consequence of the mining and financial operations incidental to the exploitation of mines in Western Australia, he would have been compelled to give a figure so big as to be appalling; and if he had stated the proportion of productive mines among the thousands of leases granted to prospectors and syndicates, he would have been forced, by his regard for the truth, to name a ratio highly discouraging to the simple people who regarded every hole in the ground as a mine in the making. But such facts would not have surprised the experienced, for in mining, as in other forms of human enterprise, the proportion of success was small. Western Australia had been much in the limelight of criticism, but he doubted whether the story of her mineral development was essentially different from that of other famous mining regions. Western Australia was to blame for some, but only the lesser part, of the vagaries that disgraced the boom of an earlier decade. Most of the spoofery was exogenous. Nor need mining be blamed as an industry for the absurdities of which it was the unfortunate victim; one might as well blame the breeders of fine horses for the cheating of the race-course and the iniquities of the turf. The author had referred to the money lost by over-rating prospects and by over-valuing mines. At the present time renewed interest was being aroused in Western Australia by reason of the finding of remarkably rich ore near Southern Cross. It was evident that the Bullfinch Mine contained a fine ore body, but he thought that hardly justified the Premier of Western Australia making the statement publicly that "even Kalgoorlie and the Golden Mile sink into insignificance when one listens to reports regarding the (Bullfinch) property, which bids fair to eclipse anything discovered in the history of the

State." He (Mr. Rickard) examined the bonanza mines of Kalgoorlie when at their zenith, and he knew what it meant to compare a new district with the Golden Mile. Therefore he said that the Premier exaggerated greatly. It looked, however, as if mining in Western Australia was about to undergo fresh expansion, for promising new finds had been made at Yilgarn, Meekathara, and Youanme, and they would all unite in wishing that those discoveries might afford the basis for an enlarged and most profitable industry.

Mr. E. F. KELAART said he had listened with very great interest to Mr. Rickard's remarks, as he came from within a mile of that Throgmorton-street to which Mr. Rickard had alluded, and happened in 1899 to be a dealer in the market when mines were continually being floated. He could not help thinking of the vast amount of money the poor people of London had put into mines, owing to puffs in the papers and the marvellous descriptions that had been given, but he supposed people would be sportsmen and go into mines on the chance that the speculation might turn out well. When he was on the market there used to be mines put forward which he half suspected never existed; in fact, there was one mine he remembered which he dealt with himself and dealt with on the basis that the mine never existed. He did not hold a brief for the Premier of Western Australia at all, but he was informed that the mine referred to by Mr. Rickard was 145 acres in extent, and that reports had been received from mining engineers that down to 100 ft. there was so much, which on being totalled up came out to seven-hundred thousand. There were many things ready to be floated and people were racing to see who should get there first, and he was glad to have been present at the meeting to gain experience which would prevent him and his friends being so ignorant as to jump into things without enquiry.

Mr. E. T. SCAMMELL hoped that the Government of Western Australia would circulate the paper very widely; it should certainly go to all the mining institutions and mining schools, and also to the leading stockbrokers throughout the United Kingdom. The warnings on the one hand and the encouragements on the other given by the author should be known to stockbrokers, and if through them the information reached some of their clients it would be a very useful thing.

The CHAIRMAN (Dr. McCall), in moving a vote of thanks to the author, said Mr. Montgomery was for many years geologist to the State he himself had the privilege of representing in London, and it gave him great pleasure, as an old friend of Mr. Montgomery's, to be able to say that the people of London could accept his word about any mine without the slightest question. Mr. Montgomery had no other interest than that of the legitimate development of the country he so ably represented. He was glad to hear that the promise for Western Australia was so very good, and that the author believed there were opportunities for developing mines even in those areas where they had been working for some years. That he believed to be the case in many of the States of Australia; even within a few miles of profitable mines discoveries were being made which set one wondering why they had not been made before. Only recently there had been accounts of important discoveries on the west coast of Tasmania, quite close to the silver fields, not very far from Mount Lyell, a mine that had been known for many years. With regard to the Bullfinch Mine, he thought there might be something to be said for the Premier of Western Australia. He held no brief for that gentleman, and did not know him personally, but he thought the Premier qualified his remarks by saying, "When one listens to reports." He did not think Mr. Wilson attempted to vouch for what had been said by the prospectuses of promoters in connection with the Bullfinch at all. He regretted that Sir Frederick Bedford had been unable to remain, because he had been Governor of Western Australia, and had been well acquainted with Mr. Wilson, and might have been able to speak with more certainty. He still thought that the quoted words were qualified, and that they hardly gave a definite opinion in support of the Bullfinch, but were simply to the effect that if what was said was true, it was a very wonderful proposition. It had not been the policy in Australia to allow Government officials or any Government servant to take part in guiding the public in connection with mining properties. Personally, he was strongly in favour of the proposition tha the Government should in some measure take a responsible part in the placing of properties on the market, because he saw no reason why the Government should not allow Government geologists, men of very high standing, to give an opinion for the public benefit. After all, it was only the opinion of one man, but it had the advantage of being the opinion of a man qualified to express an opinion. It might be advisable even to go further, and allow the prospectuses to go forward with the approval of the Government. The Government were practically the owners of the mine, and, therefore, partly concerned in the proposition, and if it were well known that a prospectus issued without that approval was probably a shady one, the public would receive great protection. Whenever he had expressed himself in that direction before he had been always informed that the London public knew very well how to look after themselves. If that was the case, there must be a very large number of people just outside London who had not been so fortunate. The experience in Tasmania was that during the time Mr. Montgomery was there, there were no "wild cats." Attempts were made, but Mr. Montgomery was ready at all times to expose them, with very great advantage not only to the people but also to the country, because after all it never paid any country

to have money wasted, whether in connection with mines or anything else. At the request of the acting Agent-General for Western Australia he offered his apologies to the meeting for not being able to remain and take the chair for Sir Frederick Bedford; he was due to attend a meeting of the London County Council and had to retire early.

Mr. BYRON BRENAN, C.M.G., seconded the motion, which was carried.

Mr. A. MONTGOMERY, in reply, expressed his obligation to Mr. Rickard for the very careful way in which he had criticised the paper. It was a great pleasure to him to have a gentleman of Mr. Rickard's standing in mining matters taking sufficient interest in the subject to give very careful attention to the paper. With regard to the health of Western Australia, the death-rate was the same as the average of the Commonwealth generally, about eleven per thousand of late years, and considerably better than that of the principal European countries. Doubtless that was to some extent due to Australia being a young country without a large proportion of old people. But still the low death-rate in the Australian colonies showed that on the whole the country was very healthy. With regard to the question raised by Mr. Rickard as to the amount of capital invested in mining countries, he was well aware of the difficulty of getting a good basis on which to discuss what was proper expenditure and what should be charged against the industry; but he thought, as an industrial matter, the money which was made and lost in dealings in shares could not be said to be more than an exchange from one pocket to another, one man gaining and another man losing. As an industrial concern the amount laid out in mining work was the basis on which to judge whether the returns had been profitable or not. The amounts paid out for all sorts of work done, some of them expenses of management, were part of the necessary expense, but he thought distinction should be drawn between money which was laid out in necessary work in connection with mines and money which was made and lost in dealing with shares, flotations, and so on, where a few persons drew a large amount of money from shareholders for a property which might not be valuable. It was necessary to separate as clearly as possible the share-dealing aspect from the purely industrial aspect. As a civil servant he could hardly express any opinion at all as to the remarks of the Premier he had the honour to serve, but he thought the Chairman had already dealt with that matter as far as was necessary. As to recent discoveries, it had struck him as serious that during the last few weeks there had been so many concerns put upon the market in the bad old way, properties offered to the public on which nothing or next to nothing had been done, which were simply put forward because they were in the vicinity of a well-known concern. He was afraid that in that matter the public must protect itself. If people would speculate in untested concerns he did not know that it was necessary to be very sympathetic with them if they found there was nothing left of the "pig in the poke" but the squeal. With regard to Government officers giving reports of mining ventures, while there was a good deal that was desirable in this suggestion, he thought it would be found a somewhat difficult one to work out practically, because Governments were usually somewhat slow, and the public, when excited, demanded great speed. From his experience he did not think, if the market were at all lively, the public would wait for Government sanction—dealings would go on just the same. It would be a precaution which the public might well insist on having for their own protection, but as things were constituted he was afraid there was not a deal of hope that it would make much difference. By the last mail he had heard that the Western Australian Government had been attempting to do something in a general way by sending out not only the whole of the geological staff but the whole of the water supply staff to explore the line of country running from Southern Cross to Murchison. It was a difficult country to enter on account of want of water, and a number of wells had been put down, and the country was now being opened up. He thanked the Society for giving him the opportunity of bringing the claims of Western Australia forward, and on behalf of those present expressed his thanks, first to Sir Frederick Bedford, and secondly to Dr. McCall, for so kindly occupying the Chair.

FOURTH ORDINARY MEETING.

Wednesday, December 7th, 1910; Sir WILLIAM H. WHITE, K.C.B., LL.D., Sc.D., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Andrews, Neale, The Midland Iron Works (Newark), Limited, Newark-on-Trent.

Chamberlain, Frederick, 23, Herbert-street, West Bromwich.

Chater, Cecil William, Assoc.Inst.M.M., c/o Messrs. Mower & Co., Rangoon, Burma.

Clarke, Miss Alice Dolores, 24, The Grove, Boltons, S.W.

Hedley, Perceval Manfred Florance, The Studio, 16A, Soho-square, W.

Kiralfy, Charles I., 141, Holland-road, W.

McClean, William Newsam, 63, Evelyn-gardens, S.W.

Marlow, Thomas Gibbons, 138, Telford-avenue, S.W.

Merrick, William Altwicker, 5, Carlisle-street, Marylebone, W.

Smith, Samuel Joseph Woodham, 30, Fleet-street, E.C.

The following candidates were balloted for and duly elected members of the Society :—

Barrington, Mrs. Russell, 4, Melbury-road, Kensington, W.

Bruce-Williams, M., Green Hurst, Beaconsfield, Bucks.

Hepburn, Edward, Monkridge, Sidcup, Kent.

Jacobson, Richard, 70, Shoe-lane, E.C.

Laing, Miss Theresa T., Etal-manor, Cornhill-on-Tweed, R.S.O., Northumberland.

Wentworth-Sheilds, Francis Ernest, M.Inst.C.E., Docks Engineer's Office, Southampton.

Wolfenden, Stuart J. Norris, Conservative Club, St. James's-street, S.W.

The paper read was—

THE PANAMA CANAL IN 1910.

By Vaughan Cornish, D.Sc., F.R.G.S., F.G.S.

Introduction.

On July 11th, 1910, I arrived at Colon on the R.M.S.P. *Atrato*, and remained on the Isthmus inspecting the Canal works until the 27th, when I left for Jamaica. Returning to England by the same route, I spent two more days on the works during the month of August. I was accorded every facility for study, visiting the three divisions of the Canal in the company of the divisional engineers, going over the relocation works of the Panama railroad, and repeatedly visiting by myself positions which seemed to me of critical importance. Having paid a visit of similar duration in April, 1908, as well as a flying visit in January, 1907, I was already acquainted with the main features of the work.* I have to thank Colonel G. W. Goethals, chairman and chief engineer, and his colleagues for their great kindness. They received me as a friend, and gave me most generously of their time. To me it has been a privilege and delight to see this great work growing under their hands.

The Canal, as it is to be, is illustrated by the plan, profile and sections which accompany this Paper. They show, among other things, the following principal characters—viz., a total length from deep water in the Caribbean to deep water in the Pacific of about 50½ miles; a minimum depth at mean tide of 41 feet; a minimum bottom width of 300 feet; a sea-level canal surface of about seven miles at the Caribbean or Atlantic end, and of about 8½ miles at the Pacific end, the remaining portion being a high-level canal sustained by dams. From Gatun at Mile 8 to Pedro Miguel at Mile 39, the surface is to be at 85 feet above mean sea level, and the bottom excavation +40 feet,* and between Pedro Miguel and the Pacific sea-level portion there are nearly three miles occupied by locks, and by the small Miraflores Lake, in which the water will stand at +54⅔ feet. There will be a double set of three locks at each end of the high-level portion. Each lock has a lift of about 30 feet, a usable length of 1,000 feet, and a width of 110 feet. Intermediate gates, however, will be used for ships of ordinary size, which will reduce the amount of water required for lockage by from 30 to 40 per cent.

When I visited the Canal two years ago I was not able to satisfy myself as to the quality of the foundation upon which the Gatun Dam was to be built, and the plans for the dam itself were still undergoing repeated modifications. There was also little to show at that time whether there would or would not have been engineering difficulties of an unusual nature attendant upon the cutting of a sea-level canal. Lastly, the details of the Pacific Division (from Pedro Miguel southwards) were not then decided. It is with these matters that I shall principally deal in this Paper.

The Panama Canal is divided, like ancient Gaul, into three parts. First, the Atlantic Division from opposite Toro Point up to and including the Gatun Dam and Locks, a distance of eight miles, under Lieut.-Colonel Wm. L. Sibert. Second, the Central Division from Gatun to Pedro Miguel, thirty-one miles, under Lieut.-Colonel D. D. Gaillard; this division comprises the Culebra Cut. Third, the Pacific Division, under Mr. S. B. Williamson, from Pedro Miguel to the deep-water entrance at the Pacific, or southern end, a distance of eleven miles.

The Atlantic Division.

Foundations of the Gatun Dam.—The placing of a dam at Gatun to hold up a head of about 85 feet of water was the principal modification introduced by the Americans in the former plans for a high-level canal. By having a very high dam at the lowest possible position in the valley of the River Chagres they obtained a greatly increased supply of water for lockages, about enough to enable the Canal to be worked to the maximum of its mechanical possibilities. Much alarm was, however, caused by the current version of the nature of the foundations of the dam. This version was an erroneous one, but there is little wonder that it was prevalent, seeing that it was based upon the section and borings published in 1906 by the Board of

* See *Geographical Journal*, February, 1909.

* The levels are reckoned from mean sea level + and –

Consulting Engineers appointed by the President of the United States. This section shows the impervious clay which forms the floor of most of the valley to be traversed by two old river channels of considerable width, and reaching a maximum depth of about 260 feet. These were stated to be filled only with sand, sand and gravel, sand and shells, and such-like porous materials. The majority of the Board reported, moreover, that "it is highly probable, if not certain, that at various points the material [at Gatun] is sufficiently loose in texture to permit seepage or percolation in dangerous quantities."

In common with many others, both engineers and amateurs, I was unable, in 1908, fully to appreciate the reasons which led Colonel Goethals and his colleagues to consider such a foundation safe. Since then, however, I have read the evidence given by Colonel Goethals at Washington in 1909, and have also gone further into the matter during my recent visit to the Canal works. Apparently the persons who made the borings did not describe correctly the results of their work. What they actually did was this:—They put an iron pipe of about six inches in diameter down to about twelve feet below the surface. A nozzle attached to a hose was inserted, and water was forced down under pressure. Gravel, etc., welled up, and the material was classified accordingly. But the hole thus formed maintained itself without lining or casing to a depth of 270 feet, no sloughing in of the sides taking place. This fact indicated to Colonel Goethals, and, I suppose, to other experts, that the gorges were really filled with a good material, and that the borings had been wrongly described. Since Colonel Goethals arrived on the Isthmus in 1907 the gorges have been re-examined by the same method, but whenever a change of material occurred the water was stopped and a core of the material was obtained. In this way it was found that the gravel, sand, etc., were "surrounded by clay, compact and hard, and absolutely impervious to water."* In the course of this evidence Colonel Goethals speaks, however, of a top layer of sand and clay varying in thickness from zero to 80 feet as being pervious to water. Apparently even this portion is not, however, appreciably porous, for I now learn that a test-pit 12 feet by 12 feet has been dug by hand to a depth of −80 feet and that no water rose in the pit. The gravelly part of the material was cemented with clay, and did not allow percolation when subjected to a water pressure equal to what they will have to stand when the lake is full. Other tests have been applied—*e.g.*, two pits have been made and placed in electric communication. A solution of sal-ammoniac being introduced into one of them, no increase of the electric current has occurred, showing that there was no seepage into the second pit.

* Colonel Goethals' evidence at Washington, February, 1909.

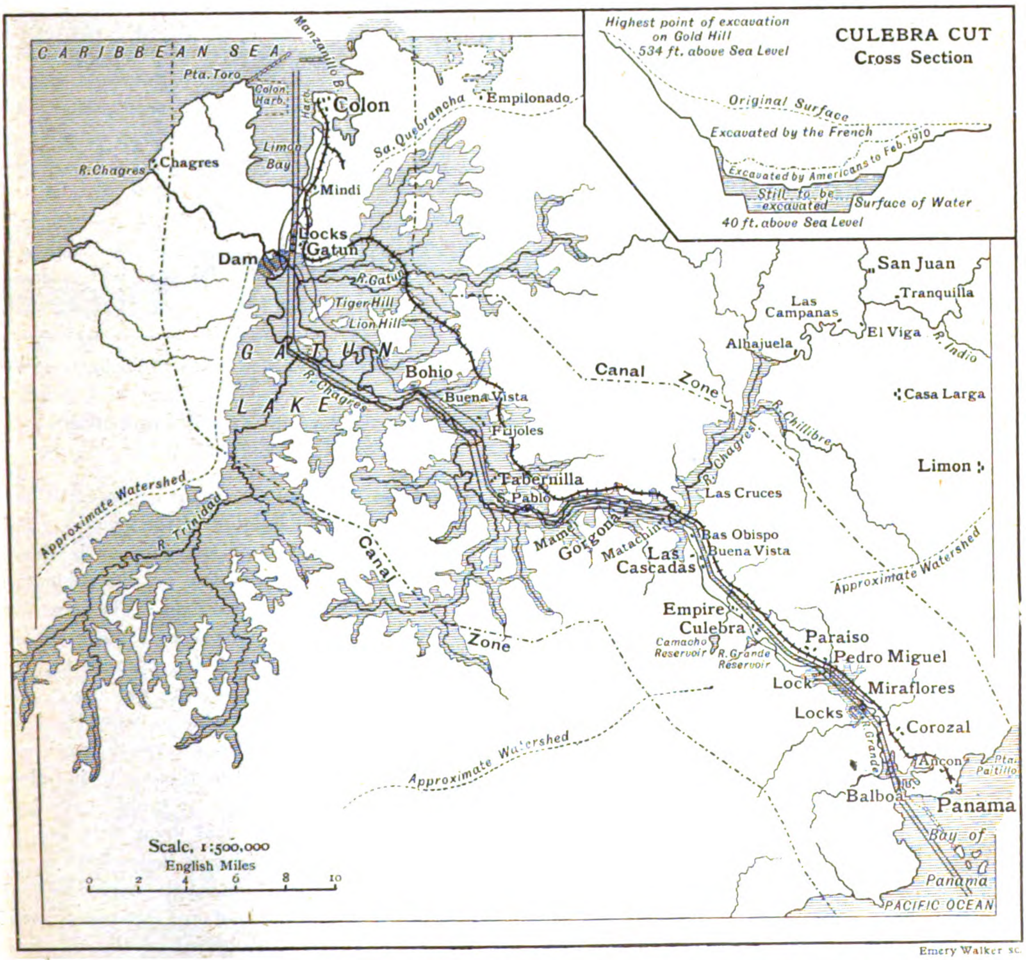
As a result of these and other tests it has been decided to revert to the first plan of a dam dumped on the surface without sheet-piling beneath. In the early days of the work on the Isthmus the engineers do not appear to have had sufficient data to enable them to answer effectually the fire of criticism and suggestion from a zealous public, and features such as the proposed sheet-piling were introduced as concessions to nervousness. The effect was not altogether happy, for it gave the idea that the experts did not quite know their own minds. Probably constructional work commenced a year too soon on the Isthmus. Now, however, neither the dam nor its foundations appear to cause the engineers in charge any anxiety, and public apprehension in America seems to be at all events quiescent, if not extinct. There may be an impression, however, that American engineers are somewhat venturesome in these matters. That those in charge of the Panama Canal are not taking risks in the matter of foundations is, however, indicated by the plans for the dams at Pedro Miguel, to which far too little attention has been given by the outside public. At Pedro Miguel the west dam supports a maximum head of 45 feet of water, or about one half that against the Gatun Dam. The material underlying the dam is impervious, with the exception of a stratum of gravel near the bed of the Rio Grande. A trench has been cut through this gravel to rock and filled with clay. Again, with regard to the wall on the east of the lock, "the natural surface of the ground between the east lock wall and the adjacent hill is at sufficient elevation, but the upper portion is more or less pervious. To cut off any possible flow the lock wall will be turned towards the hill, with which it will be connected by a concrete core wall resting on rock 550 feet long, 4 feet thick at the top, and 10 feet at the bottom." *

The Gatun Dam.—The dimensions, form, and material of the great Gatun Dam are shown in the plans and sections. At the time of my visit the rock fills were built up to +70 feet, the hydraulic fill or fine material pumped in between the rock fills being, of course, somewhat lower.

* Annual Report of the Isthmian Canal Commission for the fiscal year ended June 30th, 1909.

FIG. 1.

FIG. 2.



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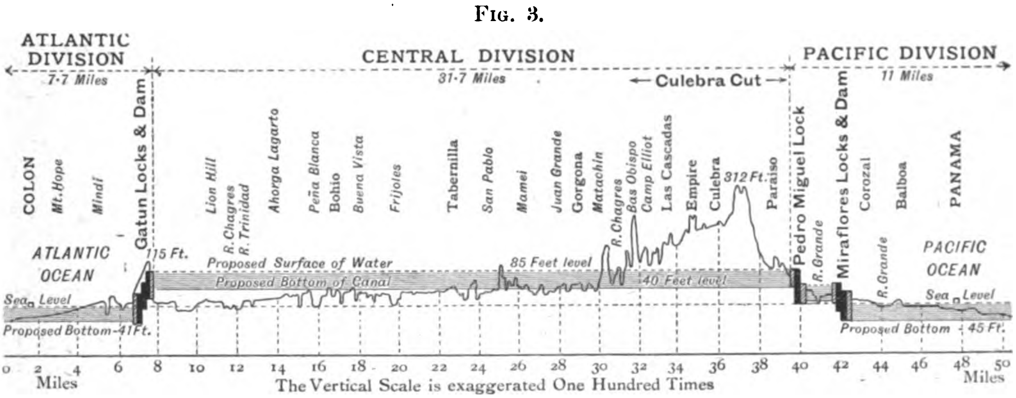
The water drains off from the hydraulic fill through pipes, and the silt settles and packs tightly. Essentially, the rock fills secure stability whilst the hydraulic fill secures impermeability. The former ensure that the dam shall not be pushed bodily to the north by the pressure of the water in the lake. The latter, which occupies the space between the rock fills, ensures that the waters of the lake shall not percolate through the dam. The devices by which an immovable and impervious dam is constructed of loose and fragmentary material are an excellent example of the subtle methods of the civil engineer. It should be noted that the material on which the engineers rely for the impervious centre of the dam is the same in substance as that on which the dam is founded, for they simply pump up the alluvium covered by waters derived from the Chagres and other rivers in the vicinity of sections alone. The slope of the surface—one in ten—is so gentle that the structure resembles a gradual swelling of the ground. The lower slopes are already so much covered with grass that I found myself walking on the dam before I realised that I had left the original surface of the ground. Moreover, no diagram can do justice to the fine-grainedness of the dam. The smallest dots which can be made upon paper are not too small to represent, on a true scale, the great blocks of the rock fill, whilst the fine silt of the hydraulic fill is actually finer in texture than the small dots made by a drawing pen.

One of the questions relating to the Gatun Dam which has been answered, more or less completely since my visit in 1908, is whether it would be too heavy a load for the ground to carry. If so, the materials would subside, and the ground not far from the dam would bulge

Fig. 3.



Profile of Canal.

This section is reproduced, by permission of the Royal Scottish Geographical Society, from the illustrations to Mr. Vaughan Cornish's paper in the *Scottish Geographical Magazine* of August, 1910.

the dam itself. This fact is advanced as an argument in favour of the impermeability of the foundations, but I think that the case for the foundations is better if it be left to rest on the experimental evidence only. The argument quoted above is not a good one, because it leaves out of account the possible effect of difference in the mode of deposition of the material.

With regard to the stability of the surface of the rock fill, one sees at once that the artificial hill is much better than natural slopes in which alternations of porous and impervious materials occur. The rock fills have no such impervious layers to become lubricated surfaces, such as cause the slipping of superincumbent material.

The appearance of the dam *in situ* gives a feeling of greater confidence in its stability than is to be attained by the study of plans and up. It is extremely satisfactory to note that there has been no bulging of the ground. This is due to the flatness of the dam, as is shown by the following experience on the relocation works of the Panama railroad. The new line was to run on an embankment some 90 feet high across the Gatun Lake, parallel to, and about half a mile east of, the old line. The ground, however, was unable to carry the load. The rock fill, dumped from a trestle, sank and spread, and the ground contiguous to it bulged up, or "humped," badly. It should have had, in fact, a load of rock laid upon it to keep it down. When the dumping of the rock fill of the Gatun Dam was commenced the engineers took no pains to spread the load, and, the pile growing steeply, a similar subsidence of the fill took place. It was a matter of small intrinsic importance, as the distribution of pressure would have

soon been readjusted by the dumping of more rock alongside. Nevertheless, the occurrence was unfortunate, as it gave rise to great alarm in the United States. The subsequent growth of the dam (which now has its final width and of which the height grows gradually, and the surface slope remains constant to within 25 feet of the top) has been unaccompanied by any deformation of the neighbouring ground. So little cause does there appear to doubt the capability of the ground to bear the heavy load piled up at a gentle slope that the engineers have not hesitated to create a deep hollow in the ground just north of the dam in the process of pumping up the hydraulic fill. It should be observed that the ground to the south of the dam will be actually relieved of much of the strain when the water is allowed to rise to its final level of +85 feet, for this will further weight it down against the thrust of the dam. Also the heavy but loose materials of the southern rock fill of the dam will be subject to less gravitational stress when the lake is full than during the process of construction, for the pressure of the water acting, as is well known, at right angles to the face of the slope tends to push the material northward, whereas gravity tends to make it tumble to the south. This thrust of the water tends, of course, to push the dam bodily northward. On both accounts the northern face of the dam is built at a still gentler slope than the southern.

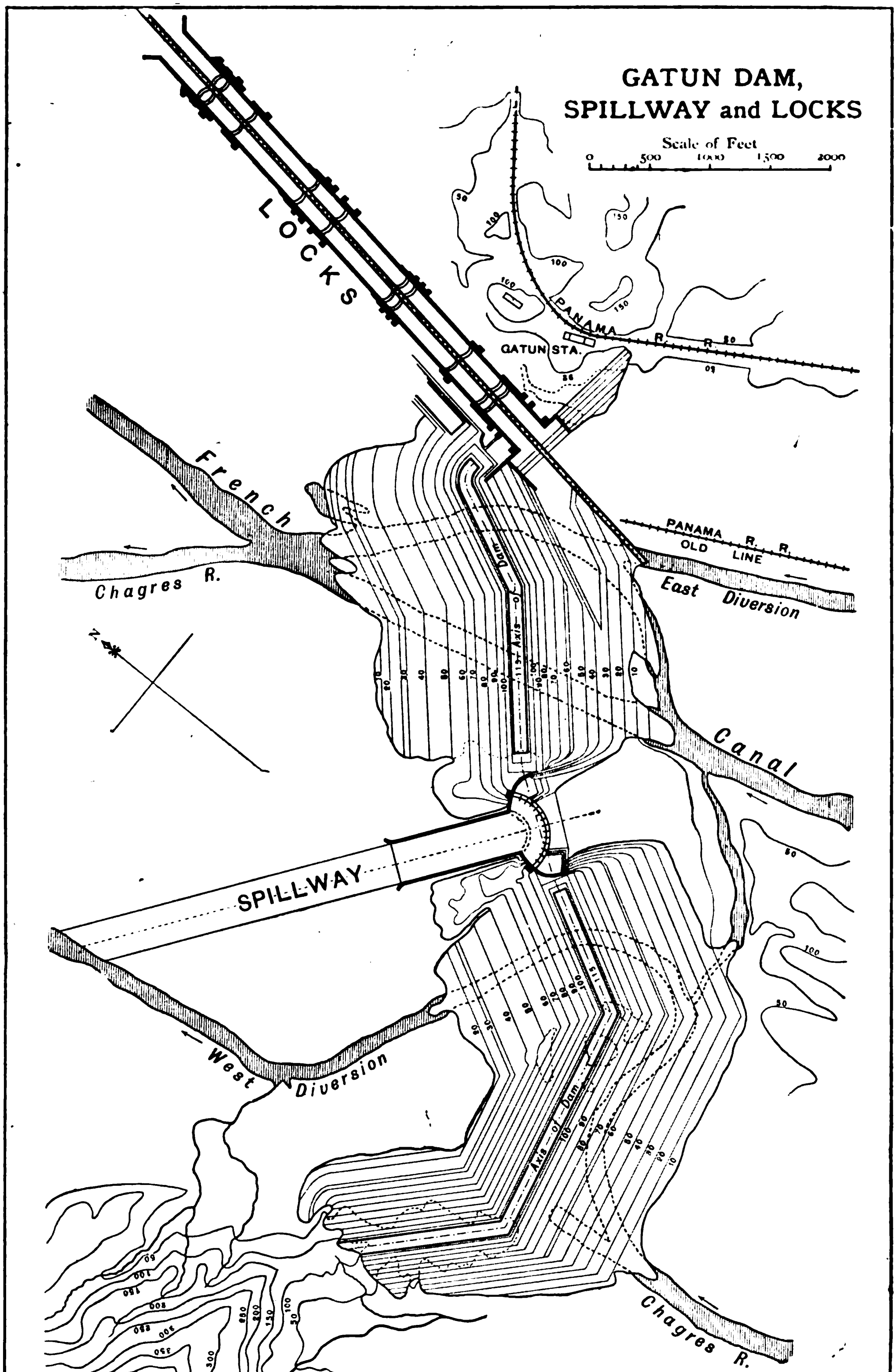
An important stage in the construction of the Gatun Dam had been reached before the date of my recent visit. The Chagres had been flowing to the sea by the channel marked on Fig. 4 as the West Diversion. Meanwhile the channel, called the Spillway, had been prepared. This is a concrete-lined channel, 300 feet wide, cut through a low rocky hill which projected above the valley floor, and is included in the dam. The sill, or opening, of the channel is 10 feet above mean sea level. When the West Diversion was closed the Chagres had a depth of about 14 feet. The river made a hard fight to keep its course. Great masses of rock dumped in the channel of the West Diversion were whirled away by the current. Then quantities of iron rails were dropped across the wooden trestles, and these held up the fresh loads of dumped rock. The trestle cracked under the strain, but held. Meanwhile pressure was relieved by pumping silt into the channel just above the trestle, thereby producing a shoal, and finally an island. By these means Colonel Sibert, the Engineer-in-Charge, finally succeeded in inducing the river to abandon the West Diversion and flow through the Spillway. It now pours in a swift torrent through this broad artificial channel, the chocolate-coloured waters curling back in a series of standing waves. The surface of the water is generally at about +14 feet, and this maintains a large mere or small lake above the dam, from which protrude the telegraph poles along the old line of the Panama railroad. This state of affairs will remain until the time comes for closing the Spillway by a concrete dam, about eighteen months hence. Then, when the river has been mastered, the lake will slowly fill to +85 feet, after which the surplus waters of the Chagres and other rivers will be allowed to escape through the sluice gates.

I have said that a merit of the scheme for placing the dam at Gatun was the storage of a great amount of water. Should more storage capacity be required in the future, it can be obtained by dredging up the bottom of the lake, and, in order to provide for such a possibility, the sill of the uppermost lock has been placed at +37 feet instead of +40. If, therefore, the bottom of the lake were lowered three feet there would still be sufficient depth over the lock sill with the minimum quantity of water in the lake, whereas the quantity stored when the surface is at +85 feet would be considerably increased.

The Central Division.

The Central Division extends from Gatun to Pedro Miguel, and is in the charge of Colonel D. D. Gaillard. From Gatun to the halfway point of the Canal (Mile 25, near San Pablo) there was hardly any excavation needed, the natural level of the ground along the line of the Canal being generally below +40 feet. Along this line the trees have been cut down, and the brushwood and scrub cleared away. Over the remainder of the 164 square miles of Lake Gatun the forest will be wholly or partially submerged and the trees left to rot and die, the process of clearing being too expensive. From Mile 25 to Mile 31, above Gamboa bridge, there is a good deal of excavation of soil being done. The work was particularly interesting at the time of my visit on account of the circumstance that the Chagres was here being turned into the canalized channel. About Mile 31, at the sharp bend above Gamboa bridge, begin the eight miles of continuous excavation in basalt rock, known as the Culebra Cut. At the north end the lowest or pioneer cutting was down "to grade"—*i.e.*, to the final level of 40 feet above

FIG. 4.



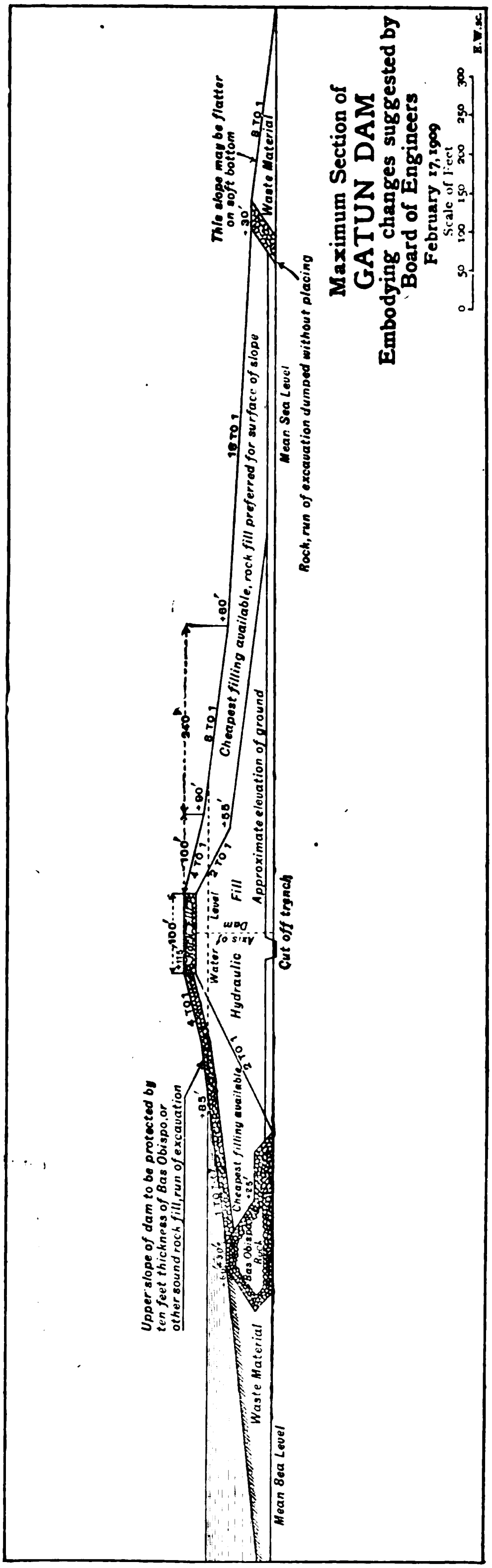
Emery Walker sc.

sea. This is three feet below the low-water surface level of the Chagres at Gamboa bridge near by. A barrier of the natural soil had been left to keep the waters of the Chagres from flooding back into the Cut. All rain-water accumulating here has to be pumped across this barrier into the Chagres. From this point the level of the bottom, or pioneer, cut rises as far as the suspension bridge at Empire, where the level is +111 feet. Thence the pioneer cut slopes southwards, so that the level is +95 feet at Gold Hill and +45 feet under the railway bridge at Pedro Miguel. These slopes are maintained partly for the purpose of draining the Cut, partly in order to facilitate haulage of the trains loaded with the spoil. Only empty cars have to be hauled up the slopes. It is in the Culebra Cut that the great collection of machinery is to be seen, particularly the huge array of steam-shovels and rock-drills. These are continually being shifted in position. As each steam-shovel is shifted, its water-supply pipe has to be shifted after it. As each rock-drill is shifted the pipe conveying compressed air has likewise to be shifted. The water-pipes and air-pipes have to be laid in the Cut, and they must be so placed as not to interfere with the trains, full and empty, which pass every point on the Cut at intervals of about two minutes. At Empire the pipes have to be carried across the Cut, for which purpose a steel suspension bridge was built. This will serve to give some slight idea of the amount of detail which has to be attended to in this division. The organisation, however, has long been perfected here and elsewhere on the Canal works, and these things now appear to the visitor to arrange themselves.

The most impressive view of the Culebra Cut is that from Culebra town, looking down into the trench and across to Gold Hill. The summit of this hill is 665 feet above the sea, and at +534 feet commences the escarpment begun by De Lesseps and continued by the Americans. The pioneer cut below is now* at +95 feet, so that the present escarpment is 439 feet in height. This is only ten feet less than that which will finally be visible when the Canal is filled with water to +85 feet. Those who visit the Canal works when excavation is complete to +40 feet, and before the water is allowed to flow in, will see an escarpment of 494 feet. The summit of the hill is 570 feet above the present pioneer cut. These dimensions do not differ much from those of the cliffs at Sidmouth. The bright green

* These levels refer to July-August, 1910, the date of my last visit.

FIG. 5.



vegetation of the summit, and the brilliant red of the earth below recalls also the colouring of the cliffs of South Devon. Only at the lower levels does the black basalt appear. The scale of the scenery is only gradually realised when one notices the little figures of the men creeping about in the bottom of the Cut among the great fragments of rock dejected by dynamite from the walls of the Cut.

When I visited the Canal works in April, 1908, the whole of the Culebra Cut was being got out as for a bottom width of 200 feet. In October of that year, however, it was decided that the bottom width should be increased by no less than 50 per cent.—viz., from 200 to 300 feet. This important change, coming at a somewhat late stage in the operations, appears to be responsible for much of the increase in the slides. These so-called slides are so serious a trouble that the centre of anxiety is now shifted from the Gatun Dam to the Culebra Cut. The widening of the Cut necessitated the cutting of fresh slopes through the clay which covers the rock to an average thickness of 15 or 20 feet. These slopes had become covered with vegetation and were fairly permanent, but when the bare ground was again exposed to persistent rains they began slipping again. But the trouble does not cease with the sliding of superficial clay. The solid rock beneath it on the banks sometimes breaks like ice in the ice-fall of a glacier, and, which is still worse, the downslip of material above is not infrequently accompanied by a humping up of the basalt rock which forms the present floor of the Cut,* and is the material of the bed or floor of the future Canal. This humping up of the bottom of the Cut during the present wet season (commencing May, 1910) has occurred at many places. The rise of the floor has been as much as 20 feet. A common view with regard to slides seems to be that as the quantity of material apparently available for sliding is not more than can be cleared up by a few steam-shovels, the sliding is not serious. Even if the calculation of quantities be correct, however, this view is, I think, unsound. What matters most is not the slipping of the banks, but the humping up of the bottom. As long as the bottom of the Cut is subject to humping it would be futile to let the water in and attempt navigation. If things went on as at present the depth of water at any point might at any time be reduced from 45 feet to 25 feet.

Of all physical processes those going on in earth slides are at the present moment the most worth study by the engineers on the Canal. These occurrences appear to me to be closely related to gravitation waves in water, and to be most easily comprehended by a bold application to them of the principles and the terminology in use by the student of superficial waves.

The "Slides" in the Culebra Cut.—Everyone is familiar with the circumstance that if on a water surface there be anywhere produced a steep slope—*e.g.*, the hole made by a falling stone or the hump made by a submarine explosion, the force of gravity produces a wave or waves. The hump subsides, and the water contiguous to it humps up. The same thing happens with the solid surface of the earth, only that the stiffer material does not go on undulating, but generally stops short at the formation of a single trough and crest, or one complete wave. I suggest the term "subsidence wave" for this occurrence. This phenomenon of a surface wave produced by subsidence of soil or rock presents itself in two forms. The first is that already described, arising from the imposition of an additional load upon a part of the natural surface, resulting in a rise of level of an adjacent part of that natural surface. The phenomenon, which is a familiar one to railway engineers, has nevertheless occurred so much more freely than was foreseen, that the proposed route of the Panama railroad from Gatun to Bohio has had to be entirely abandoned and a new route adopted, which avoids the alluvium of the Chagres valley.* The second form of the subsidence wave in soil or rock occurs not from the addition of a load but from the removal of a load, or of lateral support. Such subsidence waves or wave slides occur at many spots from Las Cascadas, near the northern end, to Paraiso, near the southern end of the Culebra Cut, a distance of about six miles.

The term "slide" conveys a misleading idea of what occurs. It suggests travel of superficial material down an incline. It suggests that every part of the material moves forwards *and downwards*. This is, indeed, what happens when shallow soil is stripped from a sloping face of rock during heavy rains.

* I am told that when the rock breaks above there is always a humping of the rocky bottom of the Cut.

* When a railway embankment is piled too steeply for the character of the material of which it is composed, the material spreads. I saw a case on the re-location works of the Panama railroad in a place where the ground was firm enough to support the load so that there was no humping of the natural surface. The slope of the embankment was, however, waved, the toe being steep and the middle part much flattened. The characteristic face of dumped material is plane. A waved surface is the sign of subsequent subsidence.

But when the soil or disintegrated rock is deep the movement of the so-called "slide" is no mere slanting descent, for the forward movement is accompanied by subsidence at the back and elevation in front. When we reflect that gravity acts vertically, we see that this form of movement ought not to cause surprise. In the case of a slide which occurred on the east side of the Canal opposite to Whitehouse* the first thing which was noticed was that the steam-shovel in the Cut was being lifted. The higher slopes were then examined and it was discovered that a crack had appeared in the soil. Afterwards the soil below and in front of this crack foundered, moving forwards and downwards with the formation of the crevasses which are the usual accompaniment of landslides.† It is easy to understand that in the hump the horizontal pressure on the earth has been increased, that it has been squeezed. The foundered part, on the contrary, having broken away from the earth behind, which remains stationary, is less squeezed than before, so that, relatively to its former condition, it may be spoken of as having undergone tension. Between the foundered part where there has been relief from lateral squeezing, and the risen part which has been subjected to an increased squeeze, there should be a nodal line where there is no change of pressure. In more than one slide it has happened that a line of rails laid upon a berm or ledge in such a situation has suffered no vertical displacement. In one of the slides which I saw, the horizontal movement in the hump was about 30 feet and the vertical about 18 feet. The whole occurrence is the conversion of an inclined plane surface into a waved surface, the foundered half being the trough of the wave, the rising part the crest of the wave. As in many other kinds of waves, so here, there is on the surface a series of minor inequalities comparable to ripples, but on account of the brittle nature of the material these take the form of cracks or crevasses, instead of wrinkles or wealds. The crevasses occur on the humped-up part as well as on the foundered portion.

Where humping of the bottom of the Cut occurs, the treatment which will be adopted will be to lessen the angle of the slope above until gravitational equilibrium is reached, which can only be known when it is found that no more humping occurs. Then if the water be allowed to fill the Canal its weight would constitute an additional security against either the bulging in of the sides of the Cut or the humping of the bottom. Superficial running of wet soil or clay might still continue, but would cause no anxiety. It would readily be removed from the Canal by dredging. This sloughing, as it is termed, is indeed viewed with satisfaction by the engineers as removing some of the weight which produces the true slides or wave slides, or subsidence waves. The slides are mainly an occurrence of the wet season (May–December). The sudden tropical downpour, of the kind which causes floods, washes off the surface layers of the soil and clay, causing the above-described sloughing. By removing in a broad, shallow, semi-liquid stream some of the soil and clay, and by puddling the surface of what is left, such downpours are sometimes beneficial in their action. It is the steady drizzle which does most harm, the kind of rain which soaks in and waterlogs the mass.

The worst slides hitherto have not occurred directly under the summit of Gold Hill, but south and north of it on the east side of the Canal, and at Culebra town on the west side. It seemed to me that the pressures which caused humping of the bottom of the Cut were always the result of underground flow of watery material.* The whole weight of Gold Hill, even at the steep slope at which it stands, does not squeeze up the bottom of the Cut where there is no watery flow. The humping of the floor of the Cut reminded me of the bulging of a wood pavement when a water-pipe has burst. The increase of fluidity due to sinking in of rain-water diminishes friction and transmits the weight of the superincumbent material laterally. The heavy rainfall of the Isthmus (90 inches per annum at Culebra), and the great depth to which the weathering of rocks extends in the humid tropics, probably accounts to a great extent for the unexpected amount of trouble from the combined subsidence and humping in the wave slides.

However this may be, their great development lately goes far to provide an answer to the hitherto unanswerable question "Should the Canal have been sea level or high level?" The main argument of the Board of Consulting Engineers against the high-level canal was that in an undertaking of such magnitude and importance, "no doubtful experiments should be

* This is near the north end of the Cut. Here the rock on the east side dips towards the Cut, and subsidence above with humping below is frequent. On the opposite side the rock dips away from the Cut, and, though covered with clay, there are no slides.

† A shovel has risen as much as nine feet in the course of an afternoon.

* Where the rock has broken above and humped below, it has had joints either vertical or inclined towards the Canal.

indulged in, but, on the contrary . . . every work of whatever nature should be so designed and built as to include only those features which experience has shown to be positively safe and efficient."

This dictum referred particularly to the contrast between a dam at Gamboa, founded on good hard rock, and the proposed earthen dam at Gatun founded on alluvium; and the argument seemed a good one. But the sea-level scheme involved a cutting which would have been 80 feet deeper than the Culebra Cut as now designed, and would have been carried also through many miles of alluvium which are not now being touched. I think the present experience with subsidence and humping in the Culebra Cut shows that a cutting to −40 feet through the Isthmus of Panama (involving a cut 574 feet deep at Culebra) would have been itself "a vast and doubtful experiment"—to make use of the Board's expression with reference to the Gatun Dam. The Board appeared to regard the making of an open cut as simply a question of yardage. It now appears that the depth is a factor which has to be reckoned with. I believe I am correct in saying that already the Culebra Cut is the deepest open cutting in the world. It has, therefore, already become to some extent an experiment. Inasmuch as few relatively comparable engineering works have been carried out in similar climates—combining great heat and high rainfall—it is the more experimental. How the rock itself at Gold Hill would behave if the Cut were carried from the present +95 feet to the −40 feet of a sea-level canal it is impossible to say; for the quality of the rock, which is so good at Bas Opispo where the Cut is shallow, gets worse as we approach Gold Hill, the deepest part of the excavation.

In the light of the experience of the last two years, I think the American Government have reason to be thankful that they did not undertake the sea-level canal, for it seems doubtful if it would ever have been finished. Had the troubles which have lately developed in the Culebra Cut been known beforehand, I think that it might even have been thought preferable to have a canal with a surface at about +110 instead of +85 feet, putting an additional lock at Bohio. With this level, and the original bottom width of 200 feet, the Culebra Cut would have probably caused but little trouble. The extra locks would have involved no new problems, and, when once committed to the necessary disadvantages of a high-level canal, it is not of capital importance whether there be six lockages or eight.

However, the present plan is not likely to be changed, and the Chief Engineer and Colonel Gaillard may be trusted to grapple with the wave slides with the energy and resourcefulness of which they have given so many proofs.

The Pacific Division.

This Division begins at Pedro Miguel and extends to deep water in the Pacific, a distance of about eleven miles. The original plan of the Commission involved a lock at Pedro Miguel and two locks, with large dams, at La Boca (now called Balboa), close to Panama. This plan was changed on the appointment of Colonel Goethals as Chief Engineer, partly on account of the character of the foundations for the proposed dams at La Boca, and partly on account of the position being exposed to gunfire from the sea. Miraflores, about two miles below Pedro Miguel, was accordingly chosen as the site for the lower locks. The work in the Division began much later than on the rest of the Canal, and the plan of the work as proposed in 1908 has since been modified. Lastly, the railway from Colon to Panama leaves the line of the Canal soon after passing Pedro Miguel. All these circumstances combine to make the Pacific Division less known to the public than the Atlantic and Central Divisions.

Coming from Culebra, the trough between the hills widens out and becomes lower as we approach Pedro Miguel, but the site of the single flight of locks is still so far confined by hills that no broad valley has to be dammed. The western dam runs for 1,700 yards from the lock wall backwards, almost parallel with the Canal, until it reaches the hills. The maximum head of water against it is 45 feet—*i.e.*, the whole depth of the water in Culebra Cut. East of the locks the ground is high enough to form a natural dam, but this is improved by a concrete core, as has already been explained. The single flight of two parallel locks at Pedro Miguel will lower vessels to Miraflores lake at the level of +54⅔. This small lake, about two miles long, receives no less than six rivers, four on the left bank and two on the right. These will supply water for the waste through the double flight of locks at Miraflores. Below Pedro Miguel lock is a concrete guide wall in the lake, and there is another in the lake above the Miraflores locks.

At Gatun, where all three locks are in series, there is only one guide wall, and the circumstance that all three locks are in a continuous

flight saves material in their construction Thus the separated locks of the Pacific end contain altogether 250,000 cubic yards more concrete than the contiguous locks at Gatun, although presenting a less imposing appearance.

The western dam at the lower end of Lake Miraflores projects forwards—*i.e.*, southwards—from the upper end of the locks for a length of 2,700 feet. It lies nearly parallel to, and near by, the western wall of the locks, and its southern end abuts on Cocoli Hill. The maximum head of water against this dam will be 45 feet. It rests on impervious material and is being constructed on the same principle as the Gatun Dam. It will be connected to Cocoli Hill and to the lock walls by a concrete core. East of the upper end of the Miraflores locks will be a concrete dam 500 feet long, which will form a spillway similar to that in the centre of the Gatun Dam. This will regulate the discharge of the six rivers which flow into Lake Miraflores. Below the double flight of two locks in series at Miraflores the Canal traverses swamps covered with vegetation for the next three and a half miles. The tides at the Pacific end of the Canal have an extreme range at Springs of 23 feet—*i.e.*, they rise 11½ feet above mean sea level. The surface of the swamps is below the high-water mark. Spoil from the Canal excavations is being spread over these marshes so as to raise the level of the ground sufficiently to prevent flooding, and in this way 450 acres will be reclaimed. This land, from its situation near the new port of Balboa and the proposed interior anchorage basin at the back of Sosa Hill, will be of great value and utility. The excavated channel of the Canal will here have a bottom width of 500 feet, and the calculated velocity of the tidal currents therein will be three-quarters of a statute mile per hour. In July the bottom was at -25 feet, but it had not yet been got out to full width. The five-mile sea channel from the docks to deep water is completed. The depth of the channel is 45 feet below mean sea level, which depth will be continued to the lowest lock at Miraflores. But the extreme range of the tides being, as already stated, 23 feet, there will be occasions on which the depth of water in this reach of the Canal may fall as low as 45 *minus* 11½—*i.e.*, 33½ feet. This, however, will never be for more than an hour or two, and the available depth for the greater part of every day will always be more than 40 feet.

The breakwater from the mainland to Naos Island is mainly to protect the Canal from the silt which drifts from the east, and formerly silted up the French canal somewhat rapidly. It is composed of rock from the Central Division. In places this has sunk, and humped up the sandbanks beside it.

A special feature of the Pacific Division is the hydraulic plant which has been erected below Miraflores. Earth excavation is to be done by means of a powerful water-jet from this plant instead of by steam-shovels.

The stone required for the concrete at Pedro Miguel and Miraflores is obtained from a quarry on Ancon Hill. Some Panamanians are employed on this work, for which they have an aptitude, and, altogether, some 250 to 300 are at work in the Pacific Division. Up to 1908 they were only employed for *machete* labour—*i.e.*, clearing bush and the like. Thus the presence of better industrial conditions seems to be slowly developing a capacity for better work among the natives. The dangerous work at heights on the locks is mostly done by West Indian negroes, who are fearless in this respect. Here they have shown themselves superior to the Spaniards. This is not the only indication provided by the last two years' experience that the negro labourer is likely to hold his own against the white navvy in the tropics.

The last feature of the work on the Pacific Division to which I need refer is the construction of scows for dredging, to avoid the voyage round Cape Horn. They are of reinforced concrete, which has a much longer life than wood in these latitudes, while being much cheaper than steel.

The metalled roads made by the Americans in the Canal zone have already produced an effect on the settlement of this fertile but empty territory. The land is taken up chiefly by coloured West Indians from Jamaica, Barbados and Martinique, who cultivate small patches and market the produce in the neighbouring towns of the zone, as, *e.g.*, Empire and Gatun.

The excellence of social and sanitary conditions on the Isthmus is maintained at the high level reached more than two years ago. After the Canal is opened on January 1st, 1915, the community which has gathered on the Isthmus will be much reduced, but there will still be a certain amount of work going on.

DISCUSSION.

The CHAIRMAN (Sir William H. White), in opening the discussion, said that the audience by their applause had signified their high appreciation of the paper to which they had just listened. He

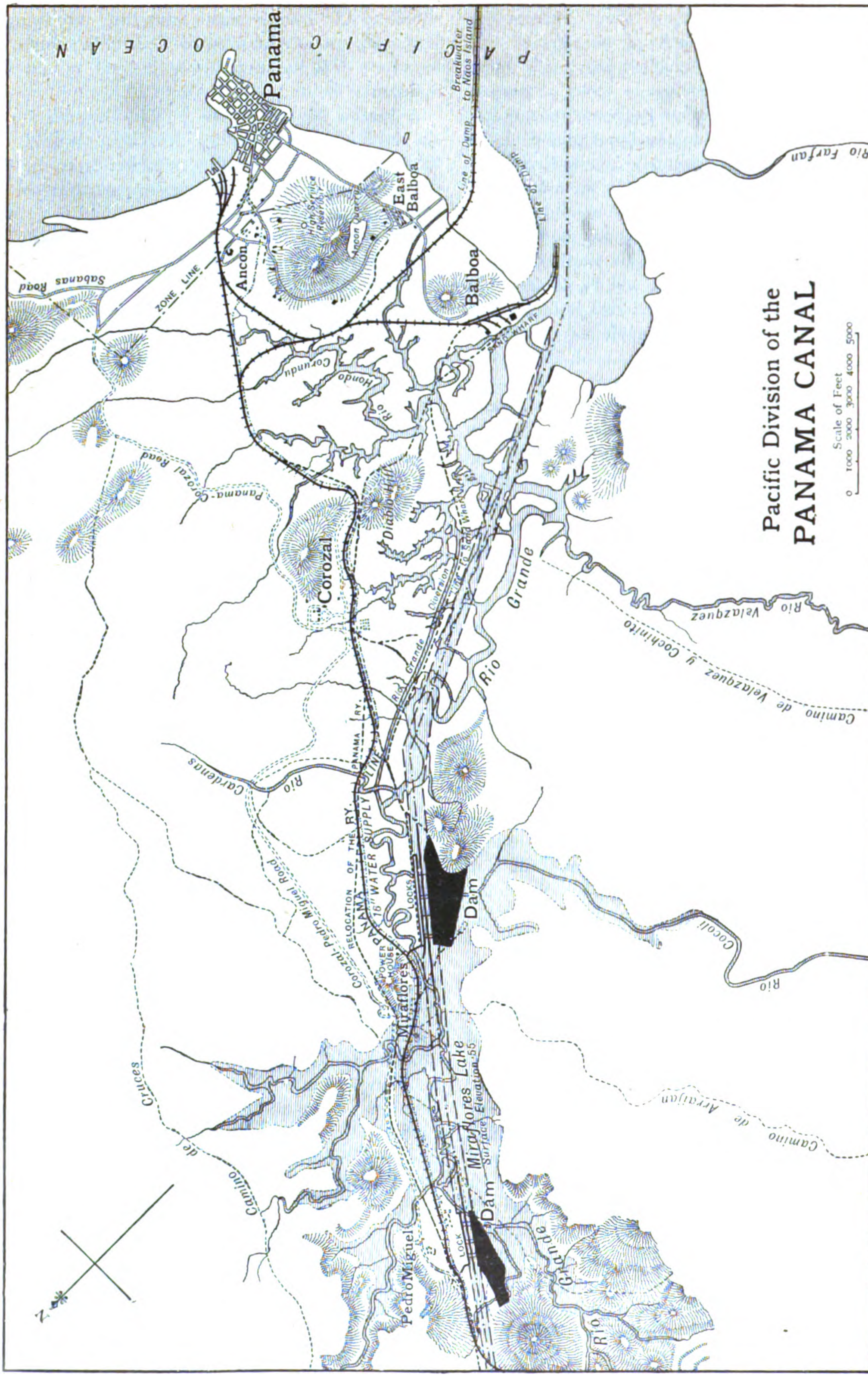

Pacific Division of the
PANAMA CANAL
Scale of Feet
0 1000 2000 3000 4000 5000
PACIFIC OCEAN
Panama
Ancon
East Balboa
Balboa
Corozal
Diablo
Miraflores
Pedro Miguel
Dam
Dam
LOCKS
LOCK
POWER HOUSE
Miraflores Lake
Surface Elevation 55
Breakwater to Naos Island
Line of Dump
Line of Dump
ZONE LINE
Sabanas Road
Panama-Corozal Road
Corozal-Pedro Miguel Road
RELOCATION OF THE PANAMA RY.
16" WATER SUPPLY LINE
Rio Hondo
Corundu
Rio Grande
Rio Grande
Rio Cardenas
Rio Cocoli
Rio Velazquez
Rio Farfan
Camino de Velazquez y Cochinito
Camino de Arraijan
Camino del Cruces
N.
Emery Walker sc.

Fig. 6.

endeavoured last year to secure the delivery of a lecture by the author at Winnipeg before Section G of the British Association meeting, but as Dr. Cornish could not undertake that labour the officials of the Association were fortunate enough to induce Colonel Goethals, the Engineer-in-Chief of the Canal, to read a paper on the subject. He thought those who had read that paper, which appeared in the Proceedings of the Engineering Section, would realise that everything that had been said by Dr. Cornish in regard to the conduct of such an enormously difficult engineering work was well deserved. It might not be known to many present that the engineers in charge of the Canal work were the engineer officers of the American Army, and it might seem strange to some people to notice that the Secretary of State for War of the United States was the Cabinet Minister in charge of the undertaking. The fact was, however, that, dating back from the early days of the Republic, the engineer corps of the Army had been in charge of the great public works of the United States, such as the improvement of harbours, which, in this country, were generally undertaken by private enterprise. At first the engineers put in charge on the Panama Canal were civilians, but for reasons into which he need not enter they were afterwards replaced by the engineer officers of the Army, and they were the men who, with civilian assistance, were now carrying out their gigantic task in such a wonderful way. Colonel Goethals sent his son, who had been on the works at Panama, straight to Winnipeg for the meeting of the British Association, and his appearance proved, if proof were needed, that, provided one lived in a proper and reasonable way, it was possible to be healthy on the Panama Isthmus. As Britishers, they rejoiced to think that the man who helped the American authorities to introduce the sanitary precautions which had attained such marvellous results in the preservation of life and health was their own countryman, Major Ronald Ross. He came home from the United States with Major Ross six years ago, when that gentleman was returning from Panama, and all the works of protection were in their infancy, and Major Ross told him, speaking on the basis of his large experience, that he was quite sure, with the precautions adopted, the Isthmus would become as healthy as any place need be. That forecast had been realised, because, as the author had stated, the death-rate was now only twelve in the thousand. There were one or two points in connection with the engineering side of the work to which he would venture to allude. First of all he desired to refer to the "slides" which the author had mentioned. There was no attempt to minimise those slides, and no fear of not being able to overcome the difficulties connected with them, as the following extract from the last annual report of the Isthmus Canal Commission up to the end of June last proved: "The total amount of material removed from all slides and breaks in the central division during the fiscal year amounted to 15 per cent. of the amount removed from the Culebra Cut." Speaking to the British Association at Winnipeg on the same subject, Colonel Goethals said: "There is only one way to deal with this, that is to remove the material." It was the very opposite of the Chat moss performance. The American engineers were not going to be stopped by anything. When men undertook to cut down into a mountain ridge to great depths, as the Americans had done at Culebra, they must face the unknown. All who had had to do with excavation, such as tunnel making, or any work of that nature, knew by experience that the crust of the earth was in a state of immense internal stress: and if anything was done to take away a part of the material which was helping to bear that stress, something which was unforeseen was likely to happen. Those who had seen the way in which, at the Simplon Tunnel, strong iron girders were crushed under the great depth of the mountain, after the Tunnel was formed, well knew that what was happening on the Panama Canal was not to be wondered at. He thought all engineers must admire the courage and endurance with which the American engineers faced such work. Even when great masses of rock were moved, and materials slid down, and the bottom humped up, as it was bound to do when the loads were so huge on either side of the cutting, the engineers did not complain; they simply went to work, as Colonel Goethals said, to "remove the materials," and they would go on doing it till they had completed their task. He quite agreed with the author's statement that the Canal would eventually be built. Mr. Taft, who had been concerned with the scheme throughout, had just visited Panama for the seventh time, and when he returned he stated that his confidence in the Canal being opened on January 1st, 1915, was still unabated. With regard to the nature of the works, it was useless to discuss any further the question of whether it would have been better to have had a sea-level canal or not. A lock canal was to be built, and the question to be considered was the scale of the work in relation to probable requirements. The author had stated that the locks were 1,000 feet long and 110 feet wide, and that there would be forty-eight lockages per day. The Americans believed that, while the Suez Canal could pass 21,000,000 tons in a year, 80,000,000 tons would be passed through the Panama Canal per year with forty-eight lockages a day. Of course, in a lockless canal like the Suez, the question of the length of the vessel did not arise, the draught being the important question which then had to be considered. He believed the draught of the Suez Canal was now down to eleven metres, and he understood the engineers were aiming at a thirty-six feet draught. The Panama Canal, however, would have forty-one feet of water, and he could not help thinking that the depth over the lock sills had been made forty-five feet, not merely to provide for possible want of water, but also, if there was sufficient water, to enable a still greater draught to be obtained in the canal, because it would not be an easy thing to alter the lock

entrances and to increase the depth over the sill. Forty feet was about the greatest depth that was now contemplated in the approaches to the great harbours of the world. The Ambrose Channel at New York was now giving forty feet, and the greatest depth at which ships were now being worked was about thirty-four feet. In the Suez Canal, where the ships travelled slowly, they always required about eighteen inches of water under their keels. The dimensions of the locks at Panama would amply suffice for any ship either in existence or planned. Contrary opinions existed as to whether ships would, in the future, exceed 1,000 feet in length. Time would show which opinion was correct, but ships had a strange habit of growing. He had no doubt that the commercial side of the matter would determine that question. Probably those present understood the importance of the point made by the author that, although the locks were 1,000 feet long, they could be shut off into sections. The gates were so arranged as to give lengths of 550 feet and 350 feet in the locks, and in that way either section could be used to diminish the quantity of water required for lockage. An important point to bear in mind in that connection was the fact referred to in the last report which Colonel Goethals made, that 95 per cent. of the sea-going vessels of the world at the present time were less than 600 feet long. The difficulties upon which he had touched were only a few of those which all people felt their American relatives had faced, and were overcoming, in one of the most gigantic engineering problems which the world had ever witnessed; and he was sure all Britishers wished them "God-speed" in the endeavour to bring the undertaking to a successful conclusion.

Mr. J. A. Saner said he desired to confine his remarks to one or two points, which, as an engineer, struck him as being of great interest. In the first place, he noticed that the Americans had reduced the top water level of the canal from the original design. Mr. Ford read a paper in 1900 before the Institution of Civil Engineers in which it was stated that the summit level of the Canal would be ninety-five feet above mean sea level. In the discussion which followed the paper, he (Mr. Saner) suggested that it would be well to leave out the summit locks; and from the section given by Dr. Cornish he noticed that the Americans had reduced the level of the upper water to 62 feet above datum, and had done away with two or three of the locks. That was a most important point in considering the difficulty of navigating large vessels through locks of any kind, and the alteration made was, he thought, a very great improvement in the design of the Canal. The author stated in the paper that it was intended to leave the whole of the vegetation in the huge lake which was being formed, with the exception of the width of the canal itself. Although it must be an almost impossible piece of work to remove 164 square miles of forest, it appeared to him that that vegetation would constitute a serious source of danger, in two ways. First of all, the timber would no doubt decay and be washed down by the floods into the channel of the Canal, and it was always a bad thing for a navigable channel to be subjected to floating timber. Not only did the timber get sodden with water, so that it was just afloat, but it lay in the bottom of the Canal; and his experience of the River Weaver was that a large number of propellers were broken through the semi-floating, and almost submerged, timber which came down from the tributaries. That, it seemed to him, was a difficulty which would have to be dealt with when the time arrived. It also appeared to him, that, with the decay of the timber, a malarial swamp would again be formed. Anything like 160 square miles of decaying timber must be a source of danger to health as well as to navigation. Another very interesting point which the chairman had mentioned, was the sliding of the banks of the deep cuttings. Engineers knew that there was a natural slope for each different kind of earth, which it would assume sooner or later after being cut into. It might not assume that natural angle of inclination immediately, the probability being that even very soft earth would stand almost vertical for some time; but as soon as the weather attacked the open cutting the earth gradually assumed a natural slope, which varied with every kind of earth. In some cases there was a slope of 1 in 5; in others 1 in 6, or 1 in 10; and sometimes it would be very nearly vertical. The American engineers appeared to have realised that fact in the making of the Gatun dam, where they had adopted a very easy slope of 1 in 10. He thought as they went on into the deep cutting they would gradually find out what the natural slope of the particular rock was at each particular place. He noticed that in the photographs shown of the deep cutting, where it was in hard rock the sides were standing nearly vertical, and that the slides took place at each end of the cutting, where there was a change in the nature of the rock, and the rock was not solid. He could not help feeling that the people of this country were rather afraid of tackling the question of canals. Some papers were read before the Society in 1888 on the importance of canals in this country, one of which he had the honour of writing himself. From that time very little was done up to five years ago, when a Royal Commission was appointed which reported on the feasibility of improving the canals of the country. He did not desire that Commission's report to be entirely shelved, but hoped England would follow the example of their American brethren, and improve their canals in the way that was being done on the other side of the Atlantic.

Mr. R. St. George Moore said that two months ago he had the pleasure of spending four days on the Isthmus of Panama, and during the whole of

that time he was not once bitten by a mosquito. The climate appeared to him infinitely better and more pleasant to live in than in Singapore. With regard to the question of a sea-level versus a lock canal for Panama, careful investigation of the conditions that obtained there appeared to him to point to the fact that the American engineers were absolutely right in building the kind of canal they had adopted. The first reason for that assertion was the difference of level between the two oceans; to attempt by lock gates to control an ocean seemed to him a very large order. In the second place, there were ample head-waters. The engineer in charge of the Gatun dam informed him that not only did the engineers anticipate having ample water for the working of the locks, but they thought there would be a sufficient water supply for lighting the whole of the Canal from end to end. The engineers stated that they did not anticipate there would be any necessity to economise water, but if it was found necessary to do so, by an arrangement of inlets and outlets to the dual locks the one lock could be utilised as a reservoir basin for the other. The large lake also formed a safety-valve for the tropical rainfalls. The third important point was that, instead of having a canal only 300 feet wide throughout its entire length, by means of the scheme adopted a canal would be built, sixteen miles of which were 1,000 feet wide.

Mr. J. G. Leigh emphasised the readiness with which the American Government and the American officials placed every detail connected with the construction of the Canal at the disposal of journalists, a plan which many English manufacturers might copy with advantage. In the course of his literary work he had been forced to obtain from the State department at Washington, or from manufacturers in America, information about English manufactures and enterprise which he had been unable to obtain in this country. The fact could not be sufficiently emphasised that the minimum width of the Canal only extended through the cutting, and that in its other parts it varied between 500 and 1,000 feet.

Dr. Vaughan Cornish, in reply, said the experience of the last two years enabled one to form an opinion as to whether it would have been better to adopt a sea-level or a high-level canal, an opinion which he was not able to decide to his own satisfaction two years ago. He thought the American Government were to be congratulated on the fact that they did not embark upon a sea-level canal. To have done so would have necessitated carrying the cutting down eighty feet lower, from plus forty feet to minus forty feet, so that at Gatun there would have been a hill more than 500 feet high towering over the cutting. How that rock might have behaved, with the possible stresses which might come upon it, and the rapid disintegration which basalt rock was liable to undergo, particularly in a hot climate, it was impossible to say. The trouble from slides would have been endless if it had been necessary to continue the cutting, not only through the eight miles of basalt rock, but through the thirty-two miles of alluvial earth; and he very much doubted if the patience of the American nation would have lasted out till the completion of the work. There would have been no end to the work, and it might have been abandoned before it was completed. The slides which had taken place had practically settled the question as between a sea-level and a high-level canal in favour of the latter.

On the motion of the Chairman, a hearty vote of thanks was accorded to the author for his interesting and instructive paper, and the meeting terminated.

FOOD CONSUMPTION IN PARIS.

In Paris, dealers in horse and mule meat are compelled by law to indicate, by means of a sign of a horse's head over the front of their places of business, the nature of their trade. This is to protect the unsuspecting public, who frequently are unable to distinguish between beef and horse meat. According to reliable statistics quoted by the American Consul in the French capital, Paris consumes in a year 347 million pounds of beef, veal, and mutton. To this must be added 79 million pounds of pork and nearly 9 million pounds of pork products. In these pork products are included the sausages and various preparations and mixtures of meat. In addition to this, the consumption of horse and mule meat is large. In fact, each year over 29 million pounds of horse and mule meat are consumed, representing about 61,000 animals. The total amount of meats of all kinds consumed annually in Paris reaches the significant figure of 455 million pounds. The amount of poultry eaten in Paris annually reaches 48 million pounds. The consumption of game attains 3 million pounds. Large numbers of rabbits are also fed and fattened for the market, and form a considerable quantity of food. That the Parisians are also great fish eaters is shown by the number of pounds sold annually, as follows: Salt-water fish, 87 millions; fresh, over 6 millions; smoked, 343,000; salted, 22,000. Total, 94 million pounds. Oysters, mussels, shellfish generally, and snails, also find numerous eaters, for their consumption is relatively important — 25 million pounds, in addition to over 1 million pounds of snails and crawfish. The consumption of vegetables in Paris reaches the following figures: —General vegetables, 31 million pounds; mushrooms, nearly 9 millions; and watercress, 13 million pounds. As to butter and eggs, Paris consumes of the former annually, 33 million pounds, and of the latter, 55 millions, and this, notwithstanding the fact that both these products command throughout the year an extremely high price, and are principally obtained from the pro-

vinces. Of late years Paris has been consuming many eggs imported from Germany, which country in turn buys from Russia, England, Italy, and America. The consumption of fruit reaches 46 million pounds annually. All fruit in Paris is sold by weight, the lowest in price being 2½*d.* per pound, and ranging from that figure to 1*s.* 8*d.* per pound. Bananas always command a high price, and are of inferior quality. As to cheese, which is never excluded from a meal in France, the annual consumption reaches over 37 million pounds, and is divided among the following kinds:—Camembert, 21 millions; Brie, 6 millions; Coulommier, 4 millions; Livarot, 2 millions; Gruyère, 2 millions; Mont Dore, 500,000; Port Salut, 260,000; Roquefort, 68,000; Contal, 62,000; Munster, 62,000; and other kinds, 2 millions.

HOME INDUSTRIES.

The Distington Explosion.—More than a year ago a remarkable boiler explosion occurred at the Distington Iron Works in Cumberland. It was one of the rare compound-boiler explosions. Of eleven Lancashire boilers in a battery, four were destroyed, and three others partly torn open. The *débris* were scattered over an area half a mile across. The Board of Trade has just issued its report. One would have thought that it might have been issued more expeditiously, for it is fourteen months since the accident occurred—but perhaps better late than never. The evidence shows that probably No. 7 boiler exploded by excessive pressure, and by the force of the explosion caused three others on its flanks to explode almost simultaneously. No. 7 had been laid off for cleaning, and it seems that an iron plate had been inserted in the pipe between the boiler and the stop-valve connecting the boiler to the steam-range, so as to keep steam from leaking into the boiler and inconveniencing the men inside. The safety-valve and the stop-valve were, however, on the two legs of a Y pipe, so that the iron plate would both cut the stop-valve and the safety-valve off from the boiler. Apparently, after cleaning, it was forgotten to remove this iron plate, so that when the steam was raised the safety-valve would be out of action and the opening of the stop-valve would not supply any outlet for the steam, but would, on the other hand, permit steam from the other boilers to have access to the safety-valve of No. 7. Hence a slight leakage at this safety-valve, or its blowing-off owing to the pressure in the steam-range, would make the attendant suppose that the safety-valve of No. 7 was in proper action, although the pressure in No. 7 might be much higher than in the others. It would seem that this is what happened, the pressure in No. 7 rising until the explosion occurred.

Folded Woven Goods.—In deference to representations made by Manchester firms, the Government of Southern Nigeria have decided to introduce into the Legislative Council a Bill to amend the Folded Woven Goods Ordinance of the Colony. The Bill will permit certain variations in the way of folding certain goods to meet the requirements of the trade in such goods, and to consolidate the various amendments now existing to that Ordinance as originally passed. The Bill contains a schedule of exempted articles which differs from any previous one. The Ordinance is to take effect as from January 1st.

The Price of Glycerine.—Reference was made in these Notes recently to the great advance in the price of glycerine, and since then there has been further rise. Chemically-pure glycerine is now over £100 per ton. The *Manchester Guardian* gives some interesting facts respecting this industry. The prices of chemically-pure glycerine are regulated by two conventions, one embracing British makers and the other Continental makers. These act independently of each other as regards prices, but they have a working agreement as to the limitation of competition in their respective spheres. The British production amounts to about 13,000 tons per annum, the French to 14,000 tons, the German to 9,000 tons, the Spanish and Italian together to 4,000 tons, and American manufacturers produce about 20,000 tons, in addition to which quantities ranging from 12,000 tons to 19,000 tons are annually imported from Europe. The great advance in prices is due to a very exceptional combination of circumstances. On the one hand the costs of production have been increased owing to the supersession of glycerine-yielding tallow by paraffin wax on the part of soap manufacturers, and the very high price of soap-making oils has tended to limit their use and divert the demand to non-glycerine yielding fats. Then there has been a large increase in the demand for high explosives owing to the many large constructive undertakings in progress, and the great expansion that has taken place in the mining industry. Probabilities point to the present high level of values being maintained for a considerable time.

New Engineering Works.—The number of new engineering works to be promoted by Bills or Provisional Orders in the next session of Parliament point to proposed improvements and extensions of existing undertakings of much importance, more especially in the case of railways and tramways, and river, dock, water, and drainage works. Amongst new railways and improvements may be mentioned the proposal of the Metropolitan Railway for a widening of the line and the construction of a new station at Mount Pleasant, between Farringdon Street and King's Cross stations. The Tilbury and Southend Company is asking for extended electrical powers, including the construction of generating stations, and the Great Northern wants to widen at Finsbury Park, as well as other parts of its system, particularly through Peterborough and from Doncaster northwards to the junction with the North-Eastern

Railway. The Midland is projecting a new direct overhead line through Bradford to take the place of the direct line sanctioned in 1898. It is also proposing new lines in connection with the King's Dock at Swansea. The North-Eastern line is promoting a widening of its Leeds and Selby Railway, with various road works in Leeds and four short railways in the Newcastle district. There are two railway proposals by new companies, and new railways are being promoted by the Manchester Ship Canal Company, and by the Great Yarmouth Port and Haven Commissioners in connection with new dock and other works. There are sixteen notices of Bills or Provisional Orders dealing with new tramways or extensions, besides the very large programme of the London County Council; power to run omnibuses and other road vehicles is being sought by several railways and corporations, and there are numerous schemes for trackless trolleys, or railless overhead electric traction. The Corporation of London is seeking power to construct a new bridge over the Thames between Blackfriars and Southwark bridges, and to rebuild Southwark bridge. The most important dock scheme is that of the Clyde Navigation Trustees.

British Industries at Turin.—The British Industrial Court at the Turin Exhibition of next year promises to be a thoroughly representative display of the various industries of the United Kingdom. It is hoped that the very successful British display made by the chemical manufacturers of Great Britain at the Brussels Exhibition of this year will be improved upon. The Chemical Industries Committee of the British Royal Commission is already considering the matter, and at the meeting of the Association of Chambers of Commerce of the United Kingdom it was resolved that "in view of the success which has attended the collective exhibits of the Chambers of Commerce at the Brussels Exhibition, and their effectiveness in directing attention to the staple industries of this country, the Association strongly recommends all the Chambers representing manufacturing industries to organise collective displays of their products, in addition to the industrial exhibits of their members, for the Turin Exhibition to be held next year."

The Consumption of Whisky.—The annual reports of the Inland Revenue, now for the first time included in the first report of the Commissioners of His Majesty's Customs and Excise, includes tables which point to a great diminution in the amount of spirits retained for consumption in the United Kingdom in the fiscal year ended March 31st last. It was only ·48 proof gallon per head of the population, as against ·72 in the previous year, and ·89 in 1901. The proportions given for Scotland are ·94 last year against 1·38 in the previous year, and 1·68 in 1901. These figures point to an immense reduction in consumption of whisky; but it must be borne in mind that they apply not to the actual consumption, but to the quantity retained for consumption—that is to say, the quantity held as well as the quantity sold. And, naturally, dealers reduced their stocks when the duty was raised. The whisky trade has been paralysed by the last two Budgets. Over-production had left it in a very depressed condition for some years before the 1909 Budget, but the imposition of the additional 3*s.* 9*d.* duty has seriously worsened the position by checking consumption.

South American Wool.—To-day South America ranks second as the producer of wool, but in many parts the difficulty in getting the raw material to shipping centres at reasonable cost is great, and will remain so until railway systems have been developed. The Bradford spinners and manufacturers do not like South American wools owing to their not working up as soft as similar wools from New Zealand. But River Plate cross-breds have shown improvement in recent years, and the *Statist*, which has an interesting article on the subject in its last week's issue, argues that there is no good reason why larger quantities of South American wools should not be used by our home-trade manufacturers, although it is a well-known fact that the produce from both Uruguay and the Argentine does not spin so well as the wools grown in Australia and New Zealand.

The Petrol Tax and Commercial Motors.—A meeting of makers and users of commercial motors was held in London last week, with the object of doing all that is possible to get the petrol tax removed. The meeting was very representative of the trade, since persons employing 40,000 men and paying 90 per cent. of the tax were present. Their case would seem to deserve the careful attention of the Government. The argument is that the tax is retrogressive; that it puts unnecessary difficulties in the way of cheap transport; that the petrol-driven vehicle is tyred with rubber and does the least damage to the road; and that to tax one form of traction is unfair. The effect of the tax on the industry is said to be very injurious.

OBITUARY.

Archibald Scott.—The death took place on the 6th inst., at his residence, South Bank, Surbiton, of Mr. Archibald Scott, in his 91st year.

Mr. Scott was appointed traffic manager of the London and South-Western Railway in 1852, and held that position until 1870, when he became general manager. On retiring from the latter office in 1885 he became a director of the company, a position which he held till his retirement in 1902. He became a member of the Royal Society of Arts in 1888.

NOTES ON BOOKS.

MODERN BUSINESS TRAINING. By John King Grebby. London: Macdonald and Evans. 3s. 6d. net.

Mr. Grebby has acted as Examiner for the Society in the subject of "Handwriting and Correspondence" since this subject was first added to the list in 1901, for he was associated in that year with Sir Courtenay Boyle, and on Sir Courtenay's death he undertook the whole of the work. He will now examine in the new subject, "Business Training," which appears for the first time in the Programme for the present year.

It may therefore be taken that he has considerable knowledge, both of the qualifications and the deficiencies of young students preparing for a commercial career, and that he is quite competent to give them useful advice and instruction. The number of such students is increasing year by year. The education for the most part provided in our primary and lower secondary schools is adapted to the wants of youthful clerks and of no other class, and the natural tendency of boys to prefer clerical to manual work is fostered and increased by their school training.

This being so, it appears desirable that the special technical training which will help boys to attain the object of their ambition should be provided, and that boys should not be left, as of old, to pick up by practice in an office the routine and method of the particular business which they may have entered. Classes, text-books and examinations are all needed, and have all been provided, and it may reasonably be expected that, on the one hand, the early work of the junior clerk may be made easier, and, on the other, that he may more quickly become capable of rendering useful service to his employer.

The field of study is a wide one, since it of necessity includes every department of trade and commerce, and though the elementary work in most offices is very similar, it soon becomes specialised, and the lad gets on most rapidly who can adapt himself to the specialities of his particular business. Hence a handbook on business training, after a general division applicable alike to all clerical work, must soon branch off to the treatment of special lines of industry. This Mr. Grebby has done. He treats not only of "goods sold and delivered," with the various devices incidental to such sale and delivery, but also of customs and excise, railways, banking, insurance, companies, the Stock Exchange, etc. The junior, and indeed the senior, clerk in each and all of these various divisions of commerce will find much of value and of practical service to him in these pages.

QUANTITY SURVEYING. By George Metson. London: John Dicks Press, Ltd. 6d. net.

This little volume is composed of material which originally appeared in the *Illustrated Carpenter and Builder*. The author is a teacher of Builders' Quantities and Building Construction at the Borough Polytechnic Institute, and his practical experience enables him to judge what his pupils ought to know and how they should learn it. He is of opinion that all building students, whether their intention is to become architects, builders, or foremen, should study quantity surveying; and there can be no doubt, as he says, that although the professional quantity surveyor fills a recognised and useful place in the building world, it is desirable that the architect and builder should know something of his work, even if it be only for the purpose of checking it. The book, which appears to be very concise and clear, will be welcome to many, not only for its excellence but for its cheapness. Hitherto it has only been possible to study the subject in comparatively expensive volumes.

THE BRITISH JOURNAL PHOTOGRAPHIC ALMANACK, 1911 (Jubilee Issue). Edited by George E. Brown, F.I.C. London: Henry Greenwood and Co. 1s. and 1s. 6d. net.

This well-known book of photographic reference has now reached its jubilee number. It commenced in 1860 with a wall or street calendar. Then there were five numbers of a pocket-size volume, and since 1866 it has appeared in its present form, though it has grown from a very slim book into one over 2¼ inches thick. Of this bulk just two-thirds are advertisements, but these advertisements are by no means the least useful part of the book. The "reading matter" comprises all sorts of tables and formulæ for photographers, with other miscellaneous information, besides including a very complete record of the photographic progress of the year.

GENERAL NOTE.

SUNFLOWER-GROWING IN RUSSIA.—The sunflower is grown in Russia to a considerable extent, the amount of seed crushed exceeding annually half a million tons. At first the centre of its cultivation was in the Provinces of Tchernigov, Kief, Poltava, and Kharkov, but now the principal cultivation of the plant has moved further south-east into the Province of Stavropol. Much of the seed is eaten either raw or roasted. The bulk of the seed, however, is pressed for its oil, which finds a ready sale as a welcome Lenten fare. Since the introduction of improved methods of refining, a very palatable oil, with a clear and pleasant yellow tint, has been produced. As a rule it is shipped in ordinary wooden casks, although lately tin canisters have been used successfully. Small shipments have been made as an experiment, and, strange to say, to such parts of the Mediterranean as are famous for their production of olive oil—its use probably being for the consumption of the people there, while the more valuable olive oil is found more profitable to export.

MEETINGS OF THE SOCIETY.

Ordinary Meeting.

Wednesday evening, at 8 o'clock :—

December 14. — Reginald A. Smith, B.A., F.S.A., "A New View of Roman London." George Laurence Gomme, F.S.A., will preside.

Indian Section.

Thursday afternoon, at 4.30 o'clock :—

December 15.—Robert Fellowes Chisholm, F.R.I.B.A., F.S.A., "The Taj Mahal and its Relation to Indian Architecture." Sir William Lee-Warner, K.C.S.I., Chairman of the Indian Section Committee, will preside.

Cantor Lecture.

Monday Evening, at 8 o'clock :—

Charles R. Darling, A.R.C.Sc.I., F.I.C., "Industrial Pyrometry." Four Lectures.

Lecture IV.—December 12.—Radiant energy—The "fourth-power" law—Laws of Wein and Planck—The Féry radiation pyrometers and indicators—The Holborn-Kurlbaum optical pyrometer—Wanner's pyrometer—Other optical pyrometers—Special uses of radiation pyrometers in pottery manufacture and work at very high temperatures.

Papers to be read after Christmas :—

Horace M. Wyatt, "Motor Transport in Great Britain and the Colonies."

Philip Joseph Hartog, M.A., B.Sc., "Examinations and their bearing on National Efficiency."

J. C. Medd, "The Dutch Labour Colonies."

Cyril Davenport, "Illuminated Manuscripts."

George A. Stephen, "Modern Machine Bookbinding." John Murray will preside.

Professor J. Wertheimer, B.Sc., B.A., "Water-Finders."

Captain A. J. N. Tremearne, "Some Nigerian Head-Hunters."

Hon. Sir Richard Solomon, K.C.B., K.C.M.G., K.C.V.O., K.C., M.A., High Commissioner for the Union of South Africa, "South Africa before and after the Union."

F. Douglas Osborne, M.Inst.M.M., "The Tin Resources of the Empire."

Reginald Murray, "Indian Banking."

R. A. Leslie Moore, I.C.S. (retd.), "Indian Superstitions."

Captain R. Muirhead Collins, C.M.G., "Australia and her Resources."

Frank M. Andrews, "Architecture in America."

Arthur Charles Davis, F.C.S., Assoc.Inst.C.E., "The Manufacture and Testing of Portland Cement."

George B. Heming, "Art Education in Jewellery and Goldsmithing."

Colonel Charles Edward Cassal, V.D., F.I.C., "The Adulteration of Food."

Dr. Leonard Hill, F.R.S., "Caisson Sickness and Compressed Air."

Sir William Abney, K.C.B., D.C.L.. D.Sc., F.R.S., "The Quantitative Measurement of Colour-Blindness."

Hal Williams, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

Noel Heaton, B.Sc., F.C.S., "The Production and Identification of Artificial Gems."

Indian Section.

Thursday afternoons, at 4.30 o'clock :—

January 19, February 9, March 16, April 27, May 25.

Colonial Section.

Tuesday afternoons, at 4.30 o'clock :—

January 31, February 28, April 4, May 9.

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Frederick Wedmore, "Etching": 1. "The Old Masters;" 2. "Modern Etching." Two Lectures.

January 23, 30.

Professor Adrian J. Brown, M.Sc., "Brewing." Four Lectures.

February 6, 13, 20, 27.

Professor J. A. Fleming, M.A., D.Sc., F.R.S., "Applications of Electric Heating." Four Lectures.

March 6, 13, 20, 27.

Alfred E. H. Tutton, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

May 1, 8, 15, 22.

Juvenile Lectures.

Wednesday evenings, January 4 and 11, 1911, at 5 o'clock :—

Professor Arthur Mason Worthington, C.B., M.A., F.R.S., "A Study of Splashes, conducted by the aid of Instantaneous Photography." Two Lectures.

MEETINGS FOR THE ENSUING WEEK.

Monday, December 12...Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. C. R. Darling, "Industrial Pyrometry." (Lecture IV.)

Mechanical Engineers, Storey's Gate, Westminster, S.W., 8 pm. (Graduates' Section.) Mr. J. C. Briggs, "Workshop and Factory Lighting, with a Special Reference to the Use of High-Pressure Gas."

Brewing, Institute of (London Section), Criterion Restaurant, Piccadilly, W., 8 p.m. Mr. W. A. Riley, "The Manufacture of Aerated Waters."

Surveyors, 12, Great George-street, S.W., 4 p.m. Mr. Robert M. D. Sanders, "The Organisation of Agricultural Credit under Land and Local Credit Societies."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. H. Beaumont, "Ruskin's Bible of Amiens."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. G. L. Elkington, "That Foreign Travel and Study retard the Development of a National Style."

TUESDAY, DECEMBER 13...Sociological (at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 8.15 p.m. Dr. J. Lionel Tayler, "Sociology and its Racial Applications."

Faraday Society (at the Institute of Electrical Engineers, Victoria Embankment, W.C.), 8 p.m. 1. Mr. James Swinburne, "Separation of Oxygen by Cold." 2. Dr. Henry J. S. Sand and Mr. William M. Smalley. "New Apparatus for the Rapid Electro-analytical Determination of Metals."

Asiatic, 22, Albemarle-street, W., 4 p.m. Mr. H. W. Codrington, "The Kandyan Constitution."

Optical (in the Chemical Society's Rooms, Burlington House, W.), 8 p m. Mr. C. F. Lan Davis, "The Theory of the Iris Diaphragm."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. H. K. G. Bamber's paper, "Portland Cement, and the Question of its Aeration."

Photographic, 35, Russell-square, W.C., 8 p.m. Professor E. J. Garwood, "Two Summers' Exploration in Spitzbergen."

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Dr. W. E. Hoyle, "The Report of the International Commission on Zoological Nomenclature presented to the Graz Meeting of the International Zoological Congress, 1910." 2. Mr. E. S. Goodrich, "On the Segmentation of the Occipital Region of the Head in the Batrachia Urodela." 3. Dr. W. N. F. Woodland, "On the Structure and Function of the Gas-Glands and Retia Mirabilia associated with the Gas-Bladder of some Teleostean Fishes, with notes on the Teleost Pancreas." 4. Mr. Oldfield Thomas, "The Mammals of the Tenth Edition of Linnæus: an Attempt to fix the Types of the Genera and the exact Bases and Localities of the Species."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. General Sir J. Bevan Edwards, "The Necessity for an Imperial Parliament."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. 1. Mr. C. A. Hill, "Note on the Crystallization of Sodium Salicylate Solution." 2. Mr. John C. Umney, "A Triangular Contest in Peppermint Oils." 3. Mr. E. M. Holmes, (a) Note on the Sleeping Sickness Fly and Tsetse Fly"; (b) "Note on Truxillo Coca."

WEDNESDAY, DECEMBER 14...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. R. A. Smith, "A New View of Roman London."

Automobile Engineers (at the Institute of Mechanical Engineers, Storey's Gate, Westminster, S.W.), 8 p.m. Dr. W. Watson and Mr. R. W. Fenning, "The Efficiency of the Two-Cycle Motor."

Engineers, Junior Institution of (at the Royal United Service Institution, Whitehall, S.W.), 7.30 p.m. Mr. G. L. Kothny, "Some Recent Developments in Condensing Plant."

United Service Institution, Whitehall, S.W., 3 p.m. Mr. W. H. St. John Hope, "The Strategical Aspects of English Castles."

THURSDAY, DECEMBER 15...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Mr. R. F. Chisholm, "The Taj Mahal and its Relation to Indian Architecture."

Royal, Burlington House, W., 4.30 p.m.

Linnean, Burlington House, W., 8 p.m. 1. Dr. Otto Stapf and others, "Reports on the International Botanical Congress at Brussels, 1910." 2. Mr. R. W. H. Row, "Non-Calcareous Sponges from the Red Sea, collected by Mr. Cyril Crossland." 3. Mr. R. S. Adamson, "Comparative Anatomy of Leaves of Veronica."

Chemical, Burlington House, W., 8.30 p.m. 1. Drs. H. E. Armstrong and E. F. Armstrong. "Studies on enzyme action. Part XV. The comparative influence of monohydric C_nH_{2n+1} alcohols and other non-electrolytes on enzymic activity." 2. Drs. H. E. Armstrong, E. F. Armstrong, and E. Horton, (a) "Studies on enzyme action. Part XVI. The enzymes of emulsin (II). Prunase." (b) "Studies on enzyme action. Part XVII. The enzymes of emulsin (III). The probable seat of origin of amygdalin." (c) "Studies on enzyme action. Part XVIII. Enzymes of the emulsin type (II). The distribution of β-glucases in plants." 3. Drs. H. E. Armstrong and J. V. Eyre, "Studies on enzyme action. Part XIX. Enzymes of the emulsin type (III). Linase." 4. Messrs. W. H. Hurtley and W. O. Wootton, "The interaction of alloxan and glycine." 5. Mr. W. R. G. Atkins, "Traube's molecular volume method applied to binary mixtures of organic substances." 6. Messrs. R. H. Pickard and J. Kenyon, "Investigations on the dependence of rotatory power on chemical constitution. Part I. The rotations of the simplest secondary alcohols of the fatty series." 7. Messrs. J. J. Dobbie and A. Lauder, "Oxycodeine: a new alkaloid from opium."

London Chamber of Commerce, Oxford-court, Cannon-street, E.C., 4.15 p.m. Mr. W. Barnes Steveni, "Commercial Resources of Russia."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. M. Phillips, "Lore, Legend, and Life 'twixt Tyne and Tweed."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Dr. T. C. Porter, "Stereoscopy with a Long Base Line."

Philatelic, 4, Southampton-row, W.C., 6 p.m. Mr. M. P. Castle, "Notes on the 1853 Issue of British Guiana, with Display."

Historical, 7, South-square, Gray's Inn, W.C., 5 p.m. Rev. J. Neville Figgis, "Respublica Christiana."

Numismatic, 22, Albemarle-street, W., 6.30 p.m. 1. Mr. H. Symonds, "The Trial of the Pyx, etc., under Charles I." 2. Mr. J. G. Milne, "Alexandrian Tetradrachm of Tiberius."

Concrete Institute (at the Royal United Service Institution, Whitehall, S.W.), 8 p.m. Mr. T. Potter, "General Concrete Practice."

Architects, Society of, 28, Bedford-square, W.C., 8 p.m. Mr. G. A. T. Middleton, "A Great London Improvement Scheme."

FRIDAY, DECEMBER 16...Geographical (in the Theatre, Burlington Gardens, W.), 8.15 p.m. Professor P. Geddes, "Inland Towns and Cities: their Main Origins." (Lecture I.)

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7.30 p.m.

Brewing, Institute of (Yorks and N.E. Section), Queen's Hotel, Leeds, 8 p.m. Mr. Otto C. Overbeck, "The Discovery of the Chemical Production of Alcohol in Fermented Beer in the Absence of Yeast."—(Scottish Section.) Caledonian Station Hotel, Edinburgh, 7.30 p.m. Dr. J. Horne, "The Water-Bearing Strata of the City of Edinburgh."

Mechanical Engineers, Storey's Gate, Westminster, S.W., 8 p.m. 1. Professor H. C. H. Carpenter and Mr. C. A. Edwards, "The Production of Castings to withstand High Pressures." 2. Mr. A. McCance, "The Constitution of Troostite and the Tempering of Steel."

Civil Engineers, Great George-street, S.W., 8 p.m. (Students' Meeting) Mr. R. N. Mirza, "Mathematical Deduction of the most Economical Ratio of Reinforcement for Reinforced-Concrete Structures."

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FRIDAY, DECEMBER 16, 1910.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

CANTOR LECTURES ON "INDUSTRIAL PYROMETRY."

On Monday evening, the 12th inst., Mr. CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., delivered the fourth and last lecture of his course on "Industrial Pyrometry."

On the motion of the Chairman, a vote of thanks to Mr. Darling for his course was carried unanimously.

The lectures will be published in the *Journal* during the Christmas recess.

INDIAN SECTION.

Thursday afternoon, November 15th; Sir WILLIAM LEE-WARNER, K.C.S.I., in the chair. A paper on "The Taj Mahal and its Relations to Indian Architecture" was read by Mr. ROBERT F. CHISHOLM, F.R.I.B.A., F.S.A.

The paper and discussion will be published in a subsequent number of the *Journal.*

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be delivered on Wednesday afternoons, January 4th and 11th, at 5 o'clock, by ARTHUR MASON WORTHINGTON, C.B., M.A., F.R.S., Professor of Physics in the Royal Naval Engineering College, Devonport, on "A Study of Splashes, conducted by the aid of Instantaneous Photography."

Each Member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to Members in the order in which applications are received.

Members who desire tickets for the course are requested to apply for them at once.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

FIFTH ORDINARY MEETING.

Wednesday, December 14th, 1910; GEORGE LAURENCE GOMME, F.S.A., in the chair.

The following candidates were proposed for election as members of the Society:—

Borthwick, Miss Jessica, 33, Rue du Jardin, Ostend, Belgium.
Eastburn, Mrs. Adelaide, 14, Ravenscourt-mansions, Hamlet-gardens, Ravenscourt-park, W.
Haslehust, Ernest W., 72, Burnt Ash-hill, Lee, S.E.
King, Alexander Freeman, C.B., 44, Foxgrove-road, Beckenham.
Miles, George W., 29, Central-street, Boston, Massachusetts, U.S.A.
Mylcrist, Captain Stanley, 560, Sunder-road, Karachi, India.
Wigram, Reginald, J.P., M.Inst.C.E., Chapel Allerton, Leeds.

The following candidates were balloted for and duly elected members of the Society:—

Briggs, Miss Irlam, Milnthorpe, Parkstone, Dorset.
Cooper, Alfred Heaton, May Field, Ulverstone, Lancashire.
McDonald, Thomas J., Assoc.M.Inst.C.E., Mansfield, Arrochar, Loch Long, N.B.
Mitchell, Hawthorn, 39, Mecklenburgh-square, W.C.
Murray, Reginald, 12, Bedford-row, W.C.
Power, John Cecil, 1, Queen's-ride, Barnes Common, S.W.
Sotham, Bernard, c/o Messrs. Lynch, Teheran, Persia, and The Priory, Iffley, Oxford.
Stanley, William Neems, 12, Spencer-road, Cottenham Park, Wimbledon, Surrey.
Wheeler, R. Vernon, D.Sc., The Colliery House, Altofts, Yorkshire.

The paper read was—

A NEW VIEW OF ROMAN LONDON.

By Reginald A. Smith, F.S.A.

At the present day little excuse is needed for introducing to a London audience any new evidence with regard to town-planning and traffic regulation; for though the present paper deals with London as it was nearly two thousand years ago, it is meant to illustrate the manner in which the engineering genius of Rome laid down the main lines of traffic in this part of Britain, before the spread of bricks and mortar made the problem well-nigh insoluble. The scope of this Society is large, but as its avowed aims do not include ancient history, geography, or archæology, it will be fitting to lay special stress on the Roman plan of London and to introduce as little as possible of the archæological evidence on which that plan is and can alone be based. A general knowledge, therefore, of the principal dates and incidents in the invasion and conquest of this island by Rome will be assumed, and particular attention directed to the history and arrangement of the main roads. The minor streets are now hopelessly lost, and do not seem to have coincided with any existing thoroughfares, many of these having been proved by excavation to have been crossed by buildings.

Those who desire a closer acquaintance with the archæological data are referred to the first volume of the "Victoria History of London," where for the first time the available published evidence has been brought together, examined and arranged, under the general editorship of Mr. Wm. Page. As a contributor I cannot dilate on the importance of this volume, which contains enough material for many divergent views of Roman London and will, no doubt, give rise to other works on the subject; but as my text is there in black and white I may, on the present occasion, deal with it in a less formal manner, and possibly present my conclusions more forcibly to an audience already familiar with the locality.

Britain was in contact with Roman civilisation a century before the conquest under Claudius, and that period of respite sufficed to show the natives whom they had to fear, and the best means of defending their shores and estuaries against a surprise attack. Till recent years the attainments of the ancient Britons have been strangely underestimated, and without exaggerating their capacity we may assume that their standard of civilisation was little below that of their Romanized neighbours across the Channel.

That chariots were extensively used by the Britons in warfare is clear from the narrative of Cæsar, and the large number under the command of Cassivellaunus in B.C. 54 implies an elaborate road system at least in his own dominions, and therefore along the north bank of the lower Thames. One of the principal duties of such a force would be to keep a watchful eye on the river traffic; and that Roman boats about sixty feet long ascended the river at least as far as Westminster two or three centuries after the time of Julius is shown by the recent discovery of such a vessel below ten feet of river mud on the site of the new County Council Hall. To watch the river it was necessary to have a regular roadway on high and dry ground as close as possible to the water, and this was practicable only on the north bank near London. East of the Lea, and a good way beyond London on the south, the banks would be useless for such a purpose; and it is interesting to find the remains of an ancient road running east and west on the brow of the hill just above what is now London Bridge. When that road was first engineered we can only surmise, but it was certainly built or rebuilt by the Romans, for an entire section of it was made and published in 1833 during alterations for the bridge-approach in what is now Cannon Street, but was then called Great Eastcheap. A gravel road 16 ft. wide, supported by two walls 7½ ft. high, was found about 3 ft. below the modern roadway pointing to London Stone on the west and apparently to Aldgate on the east, but it has not been traced east of Gracechurch Street. Narrower by 8 ft. than Watling Street, as discovered in Edgware Road, it lacked the layer of flints that distinguished the Roman military roads; but there is no doubt of its Roman construction, as the containing walls have bands of the familiar tiles between stages of Kentish ragstone. The position, however, suggests an earlier British origin, and if this road were to enable horsemen to patrol the river and give notice of any hostile approach by water, then we must imagine it continued, at least westward, along the brow of the steep northern bank, and crossed the Wallbrook, which was at that time a broad tidal river running into the Thames at Dowgate Hill. That there was a bridge here in Roman times is practically certain, as the sill of a bridge, stout

oak piling and lumps of herring-bone pavement have been found just at this point. The Wallbrook once crossed, the road would naturally proceed along the south side of St. Paul's and down Pilgrim Street to the Fleet, which was, no doubt, crossed by a ferry. Its subsequent course would be quite conjectural were it not for the occurrence of three Roman burials that exactly indicate a line that is more than probable on other grounds. It is common knowledge that the Romans laid out their cemeteries along their main roads, but the evidence of burials with regard to roads has been rather neglected in this country, and it is surprising to find how useful these scattered and accidental discoveries are in the neighbourhood of London. Indeed, the roads for which there is least presumptive evidence are the best attested by burials along their course, and the present instance is, perhaps, the most illuminating. A stone coffin was found in Howard Street, Strand, and cinerary urns under the portico of St. Martin's-in-the-Fields and at the west end of Cockspur Street. If the theory holds good, a line drawn between these sites should indicate the course of a Roman high road, and the only line that satisfies the conditions runs from Bridge Street, opposite the foot of Pilgrim Street, through the Temple, under Somerset House, between this hall and the Strand, past the National Gallery on the north (and higher) side of Trafalgar Square, under George III.'s statue and the Waterloo monument, across the south side of St. James's Square and the west end of King Street, to enter St. James's Park a little above the bandstand, whence still in a straight line it would follow the high ground to the Tyburn valley. Crossing the stream—no doubt by a bridge as the banks are somewhat steep—it would, in a few yards, reach the south end of Park Lane, and Hyde Park Corner has always been an important landmark. Nor need we give up hope of following it still further, for though connected with the Thames it could not well have crossed the low and then swampy ground south of Knightsbridge. The drainage of Pimlico is one of the wonders of London, but of quite recent date; and further west the bends of the river enclose flat areas then, if not now, liable to floods; but a road was practicable on fairly high ground to Brentford, which there is reason to believe was the objective of this ancient highway. The former importance of this town may be partly explained by a ford over the Brent and by the fact that here is a stretch of gravel in the Thames bed which made it possible to ford the river at low tide in the days before steamboats rendered a deeper channel necessary. A few years ago Mr. Montagu Sharpe convincingly argued that here was the spot where Cæsar crossed the Thames, and the existence of a large number of stakes in the north bank is in full agreement with Cæsar's own account of the crossing. For him there was only one ford, and that a difficult one, to take him into the territories of Cassivellaunus, and here, if anywhere, would be a British stronghold reached by well-kept roads. The supposed road from Brentford to Hyde Park Corner is practically in the same line as the section from the latter point to the Fleet, and in my opinion both belong to a system elaborated by the ancient Britons for their own safety and convenience. It may be remarked in passing that the road west of the Fleet, which seems to be marked out by the burials with mathematical precision, exactly coincides with the Terrace of the Inner Temple. The whole group of buildings is evidently based on that line, while the Strand frontage is ignored; and if the Terrace is, in fact, a remnant of this early highway overlooking the Thames, the curious alignment is easily explained.

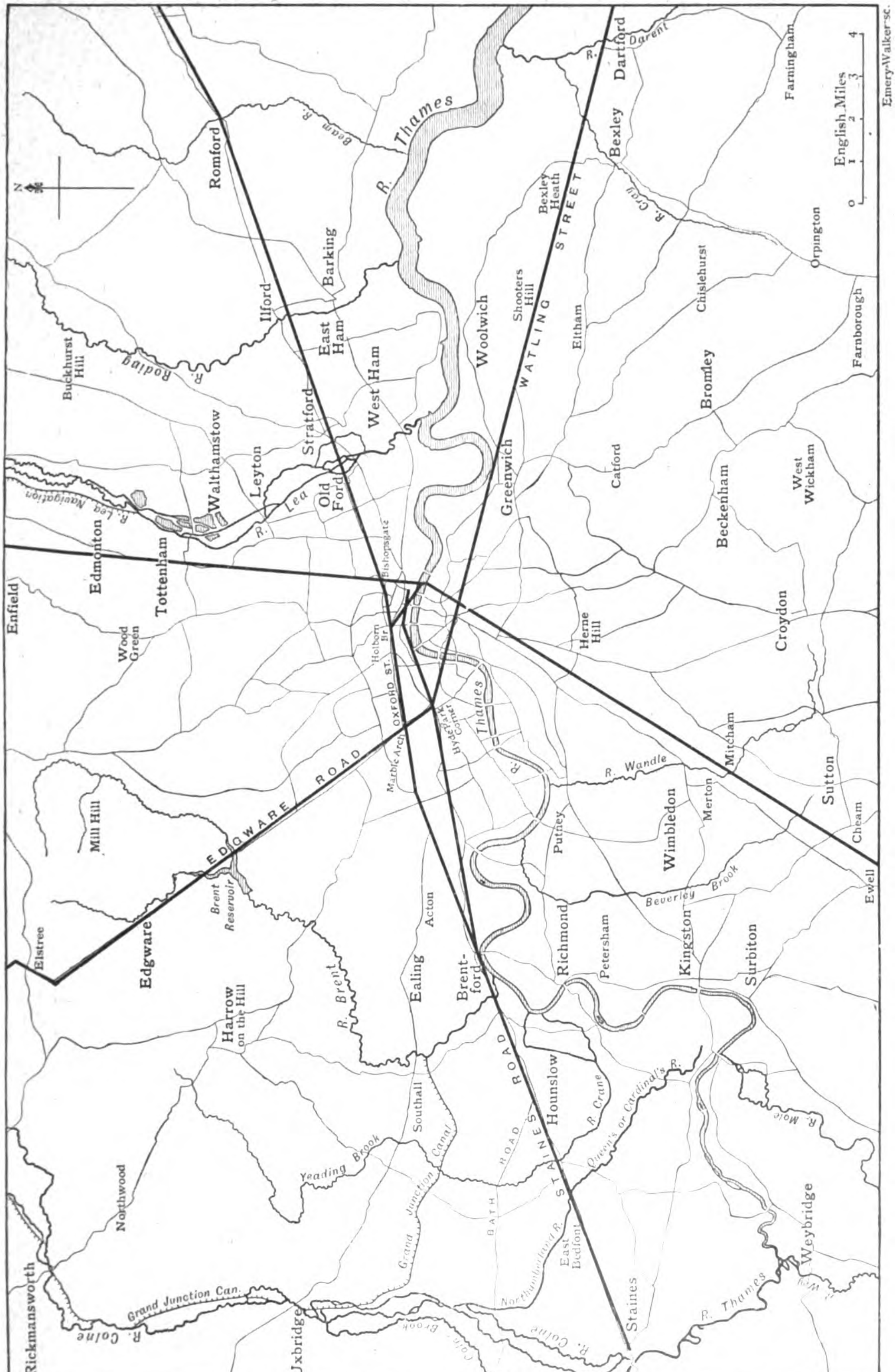
The advantages secured to the Britons by this road would also appeal to the Romans, to whose engineering skill and thoroughness may be attributed the straightness and stability of this secondary highway. Another road of more importance may also have been laid out before the Roman Conquest, but its length and directness point unmistakably to Roman initiative, and at least near London may, without much hesitation, be assigned to the latter half of the first century. Here, as in other cases, a clue to the original course of the road may be gained by producing the straight lines that still exist outside London, but a word of caution is necessary as to the name of Watling Street. In Kent there is no ambiguity, but in the Metropolis the presumed original highway of that name must be clearly distinguished from the street that runs east from St. Paul's to Queen Street. The latter will be discussed in another connection, but at first the Roman highway from the Kentish ports to Chester seems to have avoided the city and crossed the Thames at Westminster. And here may be interpolated an interesting piece of history that seems to be capable of an exact interpretation on these lines. A stage in

the conquest of Britain was marked by the arrival of the Emperor Claudius, for whom a victory had been arranged by Aulus Plautius in A.D. 43. The historian Dio Cassius was born a century later, but probably had access to documents which taught him as much about the British campaign as the ordinary Englishman knows about Trafalgar or Waterloo; hence the outlines of his story at least may be taken as correct. After the Romans had crossed a river that the Britons thought would stop them, the latter, he says, retreated to the River Thames, where it debouches into the ocean and becomes an estuary at high tide; and easily passing it, as they were well acquainted with those parts which were firm and fordable, were pursued by the Romans, who failed to overtake them; but certain Celts—who even under arms were accustomed to swim with ease over the most rapid rivers—again swimming over, and others passing a little higher up by means of a bridge, they attacked the enemy on every side and cut off many; but, rashly pressing on the remainder, they wandered into the pathless marshes and lost many of their own soldiers. This story is circumstantial enough to be credited, and there is no doubt about the river being the Thames; but the site of the engagement has been disputed. The problem is to find a short stretch of the river which at one end was just fordable and bordered on the estuary—that is, suddenly spread from a confined bed into lagoons or marshes covered at every tide—and at the other was narrow and shallow enough to be crossed by a native bridge before the Roman occupation. If estuary implies salt water the problem is insoluble, but if interpreted as above the words are in striking accordance with the report of the Geological Survey. Mr. Whitaker states that London is the first spot where vessels going up the river would find a narrow low-water channel close against ground of the most favourable kind for permanent occupation, ground, indeed, yielding every advantage that our distant forerunners could have wished for; and their choice has been fully ratified by succeeding generations who have built up the great city. Above London there are only narrow strips of alluvium, the river flowing between gravel banks and necessarily keeping to a narrow channel. Below London, however, the scene was far different from what we see to-day. The river flowed through mud plains covered with water at high tide only, and at low tide showing broad spreads of treacherous mud, as at Southend at the present day. Firm land was only touched at some of the bends in its course, as at Greenwich and Woolwich. The Lea valley may be taken as the limit of low ground on the north bank, and the river at the Custom House may well have been fordable at low tide, though dangerous to those not familiar with the crossing. Improbable as it may seem to-day to anyone standing on London Bridge, it is nevertheless supported by facts that came to light during the demolition of old London Bridge. Sir G. B. Airy, late Astronomer Royal, stated half a century ago that the depth of the foundations of the piers was good evidence of the depth of the river at old London Bridge. It appears from a published cross-section that the lowest part of the rubble, on which were laid the wooden sleepers supporting the masonry, was only from two to three feet below low water. It is certain, he says, that this could not be higher than the general bed of the river, and it probably would be lower. Some channels naturally would be deeper than the general bed; and these, when the tide had risen a little, would make the operation of fording very dangerous.

If the dangerous British ford was at or near the Custom House, the bridge was not far off; and in view of the course of Watling Street there can be little doubt that the bridge was at Westminster, which would be about $2\frac{1}{4}$ miles above the ford or, as Dio says, a little higher up. That the construction of a simple bridge here would not baffle the ancient British is suggested by the fact that in 1846 a man forded the river at this point, as recorded in the *Gentleman's Magazine*.

Towards the British bridge, therefore, at Westminster the highway was directed, and a straight line in continuation of the fine stretch of Roman road on Shooter's Hill skirts the river at Deptford, crosses the Thames a little south of the present Westminster Bridge, and reaches the southern end of Park Lane, where it may be presumed to have turned into the line of Edgware Road; for a prolongation of that road would almost coincide with Park Lane, and naturally stop at what we have already supposed to have been an important road-junction. This, at any rate, is the solution suggested by a consideration of outer London, and by the observance of the Roman rule that roads run straight unless turned aside by serious obstacles The Edgware Road

MAP 1.



ENVIRONS OF LONDON WITH MAIN ROMAN ROADS.

is an excellent example, running in a straight line till compelled to swerve in ascending Brockley Hill; and the onus of proof lies on those who would make the Roman roads crooked without weighty and sufficient reason.

Several objections might be raised to this route, and some may be briefly answered. The avoidance of London may only show that the city was not at the time important enough to divert the road, or possibly an avoiding line was chosen for through traffic, just as on a modern railway system. At first London was not a commercial centre, and Westminster also had a gravel subsoil, at least in the line of the road, and the additional advantage of a bridge. The line as restored passes very near a bend in the river at the mouth of Deptford Creek, and though some engineering difficulties would be encountered, this point of contact would furnish a site for a dock. Goods could be conveyed to this point by water more easily and more cheaply than by the road from the ports of Kent, and could here be put on shore for transport inland; and we shall see that London had its own docks later, on the north bank, a little further up the river. Leaving Deptford, the highway struck right across what is thought by some to have been a huge lagoon or morass in the Roman period; but this view of South London is clearly incorrect, as Roman remains and especially burials indicate dry and firm conditions in an area that has a subsoil mainly of gravel. Most of the burials along this line are not definitely located, but those at the Deaf and Dumb Asylum in the Old Kent Road and west of Deverell Street exactly accord with this theory, and flank the road on either side. Passing about 130 yards north of the Elephant and Castle, the line reaches the river near the middle of St. Thomas's Hospital, and the vicinity of Stangate (Stonegate) is significant, as probably preserving the memory of an approach to the river that was paved by the Romans. Stanegate is also the name of a Roman road near Vindolana (Chesterholm), just south of the Roman wall in Northumberland.

In the fourteenth century, when there were probably clearer traces of the Roman highway than there are to-day, there lived a monk named Higden who was connected both with Westminster and Chester, and had therefore probably travelled over great part of the Watling Street. In the Polychronicon he described this road as crossing the Thames to Westminster and beyond, westward to a point at which it turned towards St. Alban's. That is at least what I consider a fair reading of the text which has been variously translated and interpreted. The critical words are *ad occidentem Westmonasterii*, which I take to imply a continuation to the western part of Westminster, and not a passage of the river at a point which lay on the west of Westminster. The map shows this would be an absurdity, as the Thames, for about half a mile above and below Thorney, flows from south to north, and Westminster in those days meant Thorney. On the other hand, Higden's words seem to agree absolutely with the route suggested above.

It was long ago pointed out by Dean Buckland that a bank of gravel stretches from the river westwards almost to Buckingham Palace, and the builders no doubt availed themselves of this firm foundation for their road, which, however, had to cross some low-lying and, at that time, marshy ground before reaching the bottom of Park Lane. The lake in St. James's Park is a relic of these conditions, but had not always its present form. The road would cross about halfway between the bridge and the fountain, and to-day a stretch of lawn between two banks may mark its original course. In the Green Park also may be observed a cutting in the west bank of the Tyburn—rather steep on the north side of the Park—that lies in the direct line to the supposed junction in Piccadilly.

From the map it is fairly obvious that Park Lane represents a southern continuation of the Roman road that practically coincides with Edgware Road, and from the elbow in Piccadilly we may suppose the road ran in a straight line to Brockley Hill. Nor is this a mere supposition or tradition; the actual road was struck in 1902, almost exactly in the middle of Edgware Road, opposite Seymour Street. Another discovery, unhappily not so precise, seems to shed fresh light on the intersection of Roman roads at the Marble Arch. In Rocque's map of 1746 is marked the position of a stone against which condemned soldiers were shot inside the Park, civilian criminals being executed at Tyburn gallows just outside. It was described as a Roman "geometric" stone, that is, a stone set up as a landmark by road-surveyors, and probably inscribed with distances to various points. The intersection near the Marble Arch of two important Roman highways (the original Watling Street and that from Romford to Staines) would fully account for the position of the stone which, on the map, lies in the middle line of the avenue. It was to be seen before 1822, a few yards south of Cumberland Gate, but during alterations of level in that year for a

new gate it was covered up, being too deeply embedded for convenient removal. This in itself is extremely significant, and will be discussed later in connection with London Stone, from which it is about 3½ Roman miles distant.

The east-and-west road is characteristically Roman in its defiance of minor obstacles and adherence to the straight line, but did not actually pass through Roman London. It led from Essex across the Lea to Holborn, along Oxford Street and Bayswater Road over Notting Hill to Brentford, where it joined the British highway already noticed, and thence to Staines and across the Thames to Silchester and beyond. Though its course through Essex and west of Holborn is fairly well established, the intervening portion that skirted the north wall of the city is more conjectural, and it is only in the last few years that indications of the line have been noticed. Even without this fresh evidence, one could guess at its position by producing the line that is fairly clear from Romford to Stratford Town Hall, and this would pass through Old Ford, under Bishopsgate goods station, Finsbury Square and Smithfield to Holborn Viaduct. Beyond this the direction is slightly altered, but another long stretch takes us in a straight line to Notting Hill. That such was indeed the original route is virtually proved by the following considerations. About four years ago lumps of tiles, cemented together to form a herring-bone pavement of a common Roman type, were dredged up by the Lea Conservancy Board in the Lea just below the lock at Old Ford, exactly at the point where our imaginary line would cross the river. That there was once a ford hereabouts is clear from the name of the district, but so far as I am aware its exact position had not been previously determined. It was at Old Ford that the Lea was generally crossed before Bow Bridge was built, about the middle of the twelfth century; and it is recorded by Lysons that Matilda, wife of Henry I., caused two bridges to be built over the Lea and its tributary, the former known as Bow Bridge and stated to be one mile from the old ford. The two points are, in fact, just half that distance apart, and the Roman ford approximately coincided with the line of Iceland Street, a little below the crossing of the outfall sewer. At least two burials at Old Ford station, and another behind the police station at the eastern end of Bethnal Green Road, seem to have been connected with this road, which further west runs straight across Moorfields, a fact that might at first sight cause some misgivings. The Roman wall round London, enclosing an area of about 360 acres, was built across the Wallbrook, then a considerable tidal stream which passed through gratings in the foundations. Either through neglect or of set purpose the citizens allowed these gratings to be clogged with river-weeds and refuse, as proved by excavation in our own time, and the result was that the water was dammed back outside the wall, and in time spread over what was later known as Moorfields. This area was skated over in the time of Henry II. and remained a waste till drained and turned into a pleasure garden early in the seventeenth century. It was suggested by Stukeley that the morass was deliberately formed to protect the city on the north, but in any case we must assume that before the wall was built Moorfields was firm and dry, with a gravel soil capable of bearing a main Roman road, as is shown by a child's burial there containing a gold coin of Salonina, wife of the emperor Gallienus (253–268). Though most authorities are in favour of the fourth century, it is conceivable that the wall was already built in the middle of the third, but the morass cannot have been in existence when the interment took place. Some time after that date the east-and-west road must have been ruined by the swamp, and a way round must have been devised. The nearest high ground north of Moorfields is marked by the line of Old Street, and in this thoroughfare, where it is joined by Goswell Road, two Roman road-levels one above the other, were found in 1867 during some deep excavations which revealed mediæval roads above. This diversion enabled traffic to pass easily between Holborn Bridge and Norton Felgate, without going through the city. At Smithfield interments of both kinds (cremations and inhumations) have been found in considerable numbers, and here, as elsewhere, the angle between two main roads seems to have been a favourite burial-ground. Other burials further west give a clue to the position of the road after the Fleet was crossed by a bridge, probably at the bottom of Snow Hill. In fact, the *Gentleman's Magazine* of 1750 records that in digging the foundation for Holborn Bridge, remains of the Roman military way were discovered pointing directly to Newgate. A straight line from here to the Marble Arch does not coincide with Holborn and Oxford Street, but passes burials on its north near St. Andrew's Church, at the Birkbeck Bank, and another on the south in Endell Street. This line includes part of High Street, Bloomsbury (which was the principal street here till New Oxford Street was opened a

few years ago), and gradually approaches Oxford Street as it proceeds westward.

The two main roads that remain to be considered seem to have met on the Thames bank at a spot always of special importance to London, and probably the site of the first wharf on the north bank of the river. To determine this point we may first produce the lines of recognised Roman roads in the suburbs and then test the accuracy of the method by a survey of the archæological and historical evidence.

From Ware southwards to Edmonton there can be traced on the map a line that is continuous with the recognised Roman road that coincides with the highway from Edmonton through Tottenham and Kingsland to the City, and the presumption is therefore that the Roman north road from the Thames ran straight from the river at least as far as Ware. Its course would have been under the old Custom House, a little to the east of the present building, and about one hundred yards west of the Thames subway at the Tower. Opposite this is the point where the line of Roman road known as Ermine Street, on the Leatherhead Downs, would, if produced, strike the Thames, and this coincidence strengthens the belief that these roads were intended to join at a recognised river-crossing where the Romans doubtless erected a bridge on the site of what seems to have been the lowest ford on the river in British times. It is true that a distance of sixteen miles, between the track on Leatherhead Downs and the river, has to be covered by conjecture, except for a fragment of the road at Ewell; but if the straight line was preserved over such difficult ground as the Downs above Mickleham, it may justly be inferred that no deviation would occur on the lower ground towards London, and that the point aimed at on the river was in a line with the surviving remnant on the Downs. Some such connection must be found between these two portions of the Ermine Street (called Stane Street between Chichester and Dorking, and deflected by Box Hill), and the course suggested is not only the most obvious but is supported by a certain amount of archæological evidence. That the Roman road did not coincide with Borough High Street is proved by the discovery of a Roman tessellated floor right in the centre of the latter; and excavations in the City have made it fairly certain that the road did not swerve on entering the city walls and follow the line of Gracechurch Street to London Bridge, for thick Roman walls have been found crossing this thoroughfare. The old London Bridge was a little to the east of the present structure, and has never been proved of Roman origin. The large number of coins, from the Republic to Honorius, and other Roman relics found in the river when the foundations of the present bridge were laid, cannot be taken as decisive, for in the vicinity of a large city the river-bed is certain to contain relics at any given point, and probably as many coins and other objects will be found when the new St. Paul's Bridge is built. Further, there is no guarantee that the antiquities were dropped exactly where they were found. For instance, two halves of a Viking sword have been found in different parts of the river above London, where the scour of the tide is not so considerable.

That the Romans built a bridge to carry their high road across the river at or near the point towards which earlier British roads must have converged, is more than probable when we remember that the army under Julius Cæsar collected the timber and built a bridge over the Rhine at a point where the stream is considerably wider than the Thames at London Bridge, marched over and back again, and then dismantled the bridge, all in the space of ten days. If the Romans bridged our own Tyne, as we know they did, they would in the course of four centuries have found a bridge at London not only desirable but necessary for the traffic of the chief commercial city in Britain; and as we know that a London Bridge existed in the reign of Edgar (tenth century) we can hardly attribute it to anyone but the Romans, unless, indeed, to King Alfred.

In support of this theory mention may next be made of Stoney Lane, which runs parallel to, and a few yards east of, the Ermine Street on the south bank. This is an ancient name, and may have arisen from a paved approach to the river at this point, corresponding to Stanegate at Lambeth. There is also a Stoney Street opposite Dowgate, which has led some writers to put the crossing here, in spite of the fact that the Wallbrook was then a broad tidal river. About seven furlongs south of the river the road would cross the Watling Street, and in the angle thus formed a large Roman cemetery has been discovered in the burial-ground of a chapel (now Salvation Army barracks) in Deverell Street, New Kent Road; and burials in a similar situation have already been noticed at Smithfield. This coincidence is all the more striking, as the inhabitants of Roman Southwark seem to have buried their dead generally on the outskirts of their

diminutive settlement half a mile north of the cross roads in question.

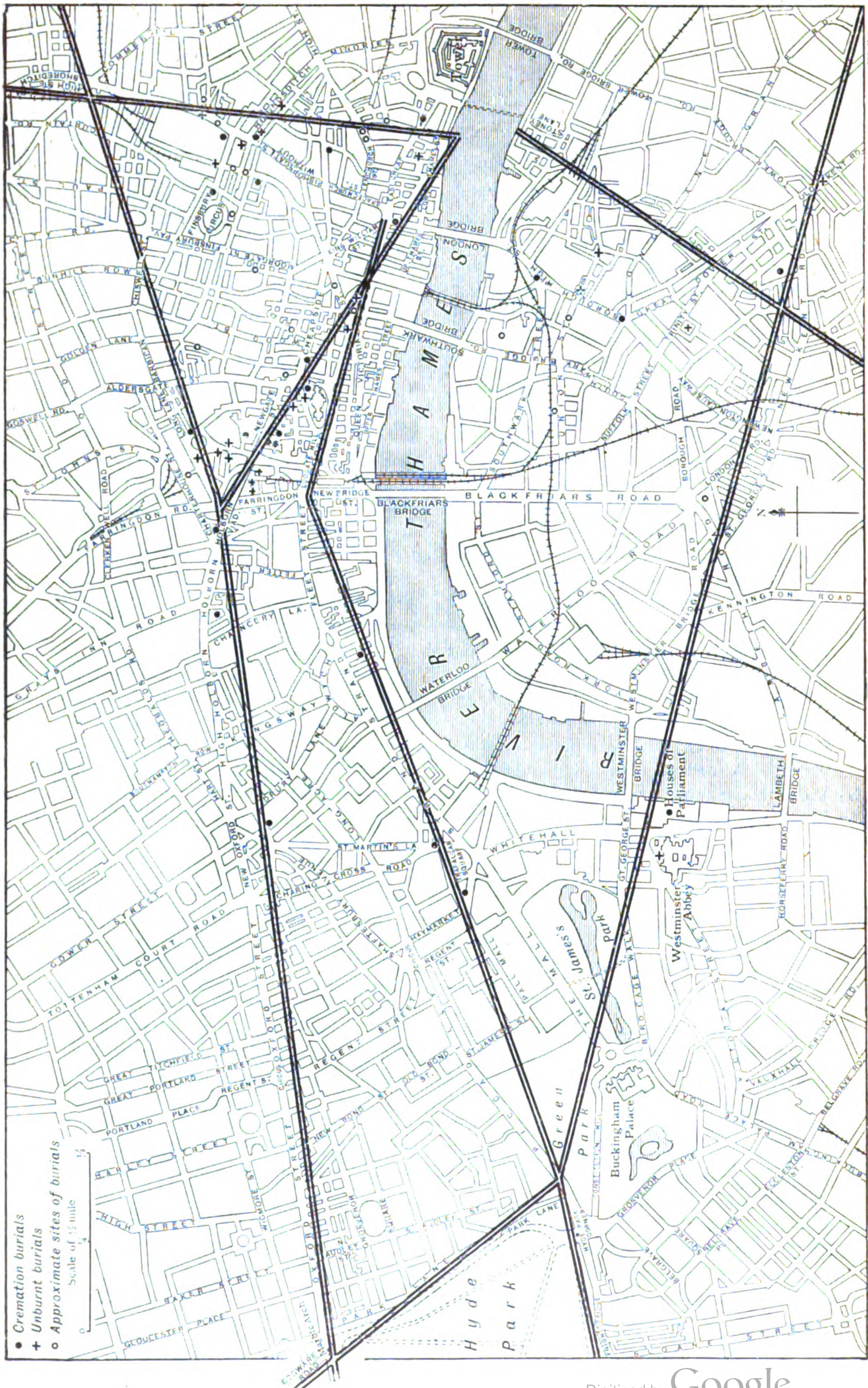
North of the river the problematic course of Ermine Street is fairly marked out by the burials in Artillery Lane and Bishopsgate Street Without, Goring Street (formerly Castle Street in Bevis Marks), Fenchurch Street, Mark Lane, and All Hallows, Barking; and Billiter Street with Mark Lane may represent the ancient line. But this line is probably not so ancient as the others. It is a curious fact that this route to the north is not mentioned in the "Antonine Itineraries," a military road-book of Britain of somewhat uncertain date, but, in its original form, attributed by the latest writer on the subject to the first decade of the third century, the name being presumably derived from the Antonine Emperor Caracalla (A.D. 198–207). Travellers wishing to reach the north were in that work directed to use the Romford or the St. Alban's road for the first part of what was a roundabout journey, and we can safely conclude that the road through Ware was not then in existence. In any case the direct route passed through marshy country on its way to Lincoln, and seems to be the last link in the road system round London. On the other hand, a road, which to all appearance started from the same point on the north bank of the river, seems to have been constructed at a comparatively early date in the Roman period, though no trace of it is to be found in the "Itineraries," no doubt because it was at first merely a branch road. Evidence has already been brought forward to show that the wall round London dates from the end of the third or some time in the fourth century, and the occurrence of burials flanking this road indicates that it was laid out before the building of the Wall. East of the Wallbrook, burials are rare within the Wall, but beyond that stream they are plentiful along the line in question; and it is difficult to believe that the Roman authorities would have tolerated burials in that area after the Wall was built. Though some of the burials date from the first or second century, there are others with the unburnt body that seem to belong to the period after the change from cremation to inhumation, which, in my opinion, took place about A.D. 250. The houses near St. Paul's, in one of which fourth-century coins were found, would, on this hypothesis, not have been built till the burial-ground was disused and perhaps forgotten, presumably after London became a walled city.

A glance at the map will show that a road was wanted to communicate with the great north-west highway known as Watling Street for conveyance of goods, not to mention troops, from the principal landing-place in London. This end would be served by the road suggested on the plan between the Custom House, where it would join the Ermine Street, and Newgate, where it would unite with the east-and-west road and cross the Fleet by one and the same bridge. In this way the detour by Westminster would be avoided; and even if the Ermine Street was in existence when this road was planned, a good mile would be saved by traversing one side of the triangle instead of joining the east-and-west road at Norton Folgate and traversing the other two sides.

This road is marked out as well as any by the burials, and though not a continuation of any known Roman highway, has actually been found about the middle of its course. This line would link up interments in King William Street, Cannon Street, Cheapside, St. Paul's Churchyard, Paternoster and Warwick Squares, Old Bailey and Newcastle Street, and though the first two sites might be explained as abutting on a still earlier British road, the rest are obviously connected with the Customs House-Newgate road, which has other points of no less interest. Its sloping course leads gradually up the steep river-bank and joins the presumably British road in front of Cannon Street Station. It is just at this point that London Stone originally stood, in the middle of the road about 35 ft. south-west of the recess in St. Swithin's Church wall, where a fragment is preserved; and it may well be that the stone stood at the intersection of two roads as the firmly-set "geometric" stone seems to have done at the Marble Arch. The history of London Stone has been traced back for many hundred years, possibly to the tenth century; and it has always been regarded as of monumental interest. Its mediæval history need not detain us; but it is important to notice that when its massive foundations were unearthed by Wren after the Fire, they seemed to him to have formed part of some public building; and tradition has it that this was the mile-stone from which all distances were measured in Britain.

The two roads that met in Cannon Street would probably cross the Wallbrook by a single bridge and part company again on the western side; that on the north passing along Budge Row and crossing Queen Victoria Street between two churches, St. Mary Aldermanbury, and St. Antholin (now demolished). Excavations in 1869 revealed a road at a depth of 10 ft. 3 in. at this spot, nearly in a line with the present Watling Street. "It was hard and well made,

MAP 2.



COURSE OF ROMAN MAIN ROADS THROUGH LONDON.

slightly elevated in the centre and formed of rough stones and gravel, in the upper portion of which were found quantities of broken Roman pottery which, with other local circumstances, would lead us to the conclusion that it marked the course of a road or highway of some antiquity." For a short distance west of this point our line runs along Watling Street, where it has been found, and the name is more or less appropriate, as this road probably superseded to a large extent the Westminster portion of the Watling Street from Kent, when London had risen into importance. Its connection with St. Paul's Churchyard is indicated by another discovery by Wren. "Upon demolishing the ruins after the last fire and searching the foundations of this Quire, the surveyor discovered nine wells in a row; which, no doubt, had anciently belonged to a street of houses that lay aslope from the High Street (then Watling Street) to the Roman Causeway (now Cheapside); and this street which was taken away to make room for the new Quire came so near the old Presbyterium that the Church could not extend further that way at first." A similar row of wells abutted on the Roman road in Cannon Street.

There is another record of flint pavement about 13 ft. from the surface, below two layers of burials on the north side of the east end of St. Paul's, and below the pavement fragments of "Samian" ware, evidently of the second century. The remarks on Roman burials near St. Paul's apply still more forcibly to the few found within the walls on the east side of Wallbrook, as in Crooked Lane, on the site of East India House and at St. Helen's, Bishopsgate. On the last site a marble cist was associated with a coin of Constantine II., which might indicate a subsequent date for the building of the Wall; but the point is that no burials seem to have been found in a well-defined rectangular area roughly bounded by the Wallbrook on the west and by Cannon Street on the south. Gresham House would be about the middle of the north side, and the east would be in a line with East India Avenue. It may be accidental that London Stone is at one angle of this enclosure, which has an area of about fifty or sixty acres, closely corresponding to that of a legionary camp. The prætorium or headquarters of such a camp would approximately coincide with the site of St. Peter's, Cornhill, under which massive Roman walls have been found extending westward to St. Michael's Church and eastward under Leadenhall Market. In the opinion of Roach Smith and other well-known antiquaries these were connected with an important public building, and an apsed building resembling a basilica was found under the market. Close by, at the cross-roads, probably the Carfax of London mentioned in two ordinances of Edward III., stood the Cornhill standard, a fountain of such importance as a landmark that distances on milestones throughout England, we are told, were measured from it as from the heart of the city. There is, therefore, some ground for considering this point the centre of Roman London. The city developed, I suggest, from a legionary camp, no doubt occupied in force at the very outset of the Roman conquest and possibly later by legions on the way to the front, but soon given over to a civil population, which rapidly made it the leading commercial city of the province. It is interesting to note in this connection that St. Peter's claims to be the first Christian church in Britain, and certainly ranked higher than a parochial church in the Middle Ages, for its school was one of four maintained by order of Parliament in London. Its foundation by Lucius in the second century is, no doubt, fanciful, but there may be some justification for the claim that it was the seat of a bishop or even archbishop in the Constantine period.

There is certainly one, and perhaps more than one, main road in or near London that awaits discovery, but perhaps those already traced will have given pause to the critical historian or archæologist. To those accustomed to the haphazard road system of modern London, the straight-edge may seem a crude and inadequate instrument for restoring the main routes of the Roman period; but our conquerors had practically a clear field and were addicted to straight roads, even in districts where they found greater natural obstacles than near London; and there are coincidences that seem to confirm the system above described. Other critics may consider that too much stress has been laid on the discovery of burials more or less in line, and may point to several burials in the London area not so arranged and presumably independent of any main road. To these I would reply that interments have been occasionally found in Britain in close proximity to Roman villas, away from main roads, and the erection of tombstones along a main thoroughfare may have appealed more to the well-to-do than to the humbler members of the community, who would be content with an unostentatious burial close at hand.

It is, from the archæological point of view, regrettable that no Roman cemetery has been thoroughly excavated and recorded in Britain, and that we have to look abroad for much of

our evidence of date. Years of patient work at Silchester, for instance, have placed before us a Roman provincial town with realistic effect, but the most useful piece of work there is still undone; the burials of its Roman and perhaps British inhabitants are still unexplored and even undiscovered, and the only consolation is that they are still intact. The records of such discoveries in London are provokingly inadequate, but they have at least been collected and examined, I hope to some useful purpose; and the results obtained may, perhaps, direct attention to this period of our city's history, and rescue from destruction any similar relics of the past that may hereafter come to light.

DISCUSSION.

The CHAIRMAN, in opening the discussion, said it was a great thing for Londoners that they possessed an official at the British Museum who devoted himself to work of the kind dealt with in the paper, in a way which showed that he built up his extraordinarily brilliant and elaborate theory from a long series of observations which involved a tremendous amount of research. He was one of those who held that Roman London was really the basis of modern London, and any research that brought forward information which proved what that Roman London was seemed to him to be of the greatest value. To Mr. Montagu Sharpe's elaborate research into Middlesex as the *territorium* of London might now be added the author's important paper on the roads of London. He wished to enter a very small protest against one fallacy which he thought the author would do well to get rid of, namely, that he seemed to base a good deal on the theory of an ancient British civilisation. There was absolutely no necessity to imagine a pre-existing British road in order to build up the Roman road theory which the author had placed before them, and he did not quite see why Mr. Smith should have drawn their attention to a British civilisation because the early Britons possessed coins and very considerable works of art. Anthropologists knew that the Maoris of New Zealand had very elaborate and wonderful works of art, but that did not prove they were a civilised race. It seemed to him that the author could very well throw that part of his research overboard and begin straight with his Roman work. He reminded him that the Celtic Britons were in the condition of tribesmen, as was proved by the fact that their post-Roman laws were tribal laws, and that it was impossible to convert tribesmen into people who built roads, not only through their own tribal territory, but through the territory of their adjoining enemies. The thorny question of the ancient Briton seemed to dominate the author's mind, because he (the Chairman) noticed one particular sentence in the paper in which the statement was made that Westminster and not London should have been the capital if its British importance was taken into account. There, again, he did not think history supported Mr. Smith. The extreme importance of Westminster in relation to London was not its British, but its Anglo-Saxon position; and he threw that out as a point which did not bear out this particular part of the author's theory. The author's theory was that the Romans buried, at all events their principal people, on either side of the roads which came out from the big city. When it was borne in mind how London had been dug into, and altered and changed, the remarkable thing was, not that so few burials, but that so many burials had been discovered. To have gone over the map of London and to have selected those burial places as the possible sites of Roman roads seemed to him a very remarkable and extraordinary piece of work. When the route of those roads was confirmed by other evidence he thought the author's theory might be taken as proven, although he confessed that when he saw the ruler going through all sorts of other roads across the modern map he was rather alarmed; but were they quite safe in neglecting the evidence of a modern road where it might give some sort of evidence of the ancient position? One other point that struck him as of extreme importance was the identification of the ancient Roman camp which was destroyed by Boadicea. That site was a very important one, and he thought the author's identification of it was a noteworthy example of his method of research. It was true it was based upon negative evidence that burials were not found within a particular area, but the evidence was very strong, and when coupled with the remarkable identification of the buildings on the site of the *praetorium*, seemed to him to be worthy of the very greatest consideration.

Mr. MONTAGU SHARPE said he had always taken it for granted that the roads which the author had described in the paper were more or less in their present position, but he had been considerably impressed with the author's statements in regard to burials taking place alongside the main roads. In the parish of Enfield he had visited a Roman cemetery which was at least a mile and a half from Ermine Street, and he knew of another Roman cemetery in the County of Middlesex which was a long way from Watling Street. He therefore desired to ask the author whether he confined his theory with regard to Roman burials only to the consular and military roads, or did he contend that burials might take place along the ordinary minor roads of the countryside? The prefecture of London embraced a large area, which must have contained a considerable population, so that there might be Roman remains all over Middlesex. Did the author hold that the Romans buried their dead by the side of the local roads, or was the burial

indiscriminate in their own grounds? If the author's theory held as regards rural burials, it would be of great assistance in tracing a great many of the minor roads in the county of Middlesex.

Mr. H. B. WHEATLEY said he was pleased to have the opportunity of expressing the great obligation every student of London was under to the author, first of all for his contribution to the "Victoria History of London," and also for the present paper, which contained one of the most remarkable contributions to the knowledge of the subject which had hitherto been written. He had been particularly pleased to hear the author's description of St. Giles's, because one of the greatest difficulties he had experienced in considering Oxford-street and Holborn as a Roman road was the way in which it went down through St. Giles's. Mr. Smith had fully explained the reason why it did so, and had, therefore, entirely overcome that difficulty. In looking at the maps which had been shown containing the Roman roads, he had been greatly struck with their number, and it was hardly possible to understand why at that early period of Roman history so many roads should be required. The idea that a bridge was built at Westminster in place of one in London seemed rather extraordinary. It appeared to him impossible that a bridge could have existed at one time and have been so completely lost. It was a point which was arguable, but it was a great shock to one's feelings, similar to that obtained from Sir Walter Besant's book where he specially contended that Westminster was earlier than London, of which there was no evidence at all. The author had rightly pointed out that the reason there was no growth at that place was because of the swampy nature of the ground. By the fourth and fifth century it was natural to suppose that many things had grown; and, as there was a part of Roman London in Southwark, it did seem as if the ordinary idea of going across from Southwark to London was correct. As to the question of a bridge, an important point in the author's argument was that it was built by Britons. It was natural to suppose the Britons would have experienced difficulties in bridge-making which the Romans did not experience. From the Roman point of view it seemed to be not a question of building the bridge at the shallowest part of the river, but at the narrowest, and the district at Westminster would be rather wider than, or as wide as, that at London Bridge, excepting that part which was swampy on the other side. That seemed to be the great difficulty in connection with the possibility of a bridge being built at that time; it depended very much on the use of the road.

Mr. WILLIAM PAGE thought the author's remarks with regard to the course of Watling Street, crossing the Thames from the south side to Westminster and going through to St. Albans, threw a light on the question of the early status of London. It would be remembered that the goal of Caesar's invasion was Verulamium, and when Claudius invaded this country, the only place which the Romans made into a *municipium* was Verulamium. Hence he thought that Verulamium was the most important town in southern Britain, and probably the most important in all Britain. The first time that London became of importance was on the insurrection of Boadicea in A.D. 60, and it was then coupled with Verulamium and Colchester. The position of London was afterwards recognized by the Romans as being far more important, and towards the end of the first century it became a much more important town than Verulamium. With regard to the geometric stone at the Marble Arch, to which the author had referred, that part of Middlesex was in the Hundred of Ossulston. In a minister's account of the Manor of Ebury at the Record Office, there was a description of various farms in Ebury which extended up to Oxford-street, and in the northern part of the Manor of Ebury there was a reference to a farm very close to Osolveston, which was the old form of Ossulston. Such a geometric stone would be the sort of place which would be chosen for the meeting of the Hundred Court. With regard to the road that ran from Chichester to London, the author mentioned that that road must have been made after the date of the Antonine itinerary, about A.D. 320; and if that was the date of that road, was it not also the probable date of the Roman London Bridge?

Mr. MILL STEPHENSON could not understand the importance which the author attached to Westminster. Débris of a Roman city had been found in the City, whereas practically nothing had been found at Westminster except the doubtful burial to which the author had referred, where a Roman coffin had been found with a Christian lid. It was very unfortunate that it was impossible at the present moment, owing to the attitude taken up by the owner of the land, to explore further the Roman cemetery at Silchester.

Mr. T. F. ORDISH thought the drawing of lines on a map in accordance with the Roman cinerary urns discovered along them, and indicating in that way the course of the Roman roads, was a fruitful field of research which many people would like to adopt, but unfortunately they did not possess the information which was at the author's disposal. He thought all interested in the subject had cause to be grateful to the author for the immense amount of work he had done in that direction. When London was rebuilt, it was rebuilt on the old ways, the alignment of the roads being made very much the same. Many investigators had discovered that the landmarks of property and manors showed that the line of the roadway was permanent. He mentioned that point because there was an important difference between the lines drawn by the author in the case of many of the Roman roads and those that existed at the present time, which, in a general way, had been supposed to be based upon the Roman system.

Mr. Reginald Smith, in reply, said the Chairman had maintained that he exaggerated the standard of civilisation among the ancient Britons, but every year evidence was forthcoming on that point. When it was borne in mind that it was only within the last thirty or forty years that any attention had been given to ancient Britain and the early Iron Age it was astonishing that in that short period so much information had been obtained, and he was daily expecting further discoveries on the subject. Until more was known about the ancient Britons, he thought they ought to be given the benefit of the doubt. The Anglo-Saxon importance of Westminster was no doubt true, but there was certainly a Roman settlement there. The settlement at Thorney could only have been small, but within the last few months Mr. Lethaby, who was in charge of the fabric of the Abbey, had informed him that further discoveries had been made in the Abbey itself. For instance, there were two or three finds, which he could not quite locate, in the Close, and quite recently fragments of a pavement three inches thick, as well as several roofing tiles, had been discovered under the apse of Edward the Confessor's Church. He was not surprised to hear there were burials outside London, and even cemeteries which did not flank Roman roads, but he preferred to judge each case on its own merits. If Mr. Montagu Sharpe could show, in his wanderings around Middlesex, lines of burials as well as cemeteries, and connect them either with his (the author's) system of roads, or work out a system of his own, he would be happy to see such work done, but there were cemeteries not connected with roads. For instance, just south of Old Ford, outside the area of the City, on the bank of the River Lea, there was a bunch of six or eight burials, which, as far as he knew, were not connected with the road. He supposed the land flanking the Roman road was monopolised by the well-to-do, just as the best situations in cemeteries were at the present time, and the other people had to be buried wherever a place could be found for them. Mr. Wheatley had asked why there were so many roads. He could assure Mr. Wheatley that there were many more not yet discovered, and he hoped to be able to find the track of the road which was a short cut from Deptford Creek to London Bridge. Most people thought that the Old Kent Road was such a branch road, but he was persuaded that the short cut, if it ever existed, was not exactly on that line, and was certainly later than some of the other roads he had mentioned. He believed the riparian road was not only a main road but an important strategical road. Troops going to the front would have to pass through London and be despatched in all directions. Hence London was the key of the road system, just as it was the key of the railway system at the present day. He hoped some important main roads would be discovered, or at least some burials, between Deptford and London Bridge which would give a key to the situation of the cross-road which he felt must have existed. He could not believe that the road was ever swamped by the Thames in Roman times; it was at all states of the tide above the water level, being practically on the level of the Strand, and it was chosen by the Britons for that reason. When the Romans improved the road, and built up the retaining walls to keep the gravel firm, there was not so much need for the road as before. The Romans policed the country so well that they found they did not need specially to watch the River Thames, and their troops were more useful elsewhere. At any rate, that road might have been superseded by the east-and-west road that came from Romford and went through the north of London past the Marble Arch, over Notting Nill. He believed that was the true Roman road more or less superseding the lower road, which might have been dangerous and boggy in some parts. Mr. Page had reminded him that Verulamium was the centre of south Britain at that time. All the more reason, therefore, that the road which came up from Kent should go direct to Verulamium. London was not so important as Verulamium, in fact, it hardly existed in the first century; therefore the road went on a straight course without regard to London at all. Even after London became an important commercial centre it was quite possible that the Romans went through Westminster, just as a modern railway made what was called an avoiding line outside a busy centre so that through trains could go past the town instead of through it. Mr. Page's discovery persuaded him more than ever that the geometric stone at the Marble Arch was the stone of Ossulston, and great credit was due to Mr. Page for that interesting discovery. With regard to London Bridge, he was quite certain that the Romans did join up Ermine Street over the river by a bridge. When it was borne in mind that the Romans built a bridge over the Rhine, which was twice the width of the Thames at London Bridge, and destroyed it again all within ten days, one could not help thinking they would build a bridge of stone or wood to join up two of the most important roads in the kingdom. If they did not do it, who did? London Bridge was heard of in the reign of Edgar. He did not think the early Saxons would have been the people to build a bridge across an important river like the Thames, and he thought if King Alfred had built the bridge he would have said so. Mr. Stephenson could not have heard of the recent discoveries at Westminster, otherwise he would have known that many Roman remains had been found there. He also hoped public opinion would have some effect on the obdurate owner of the soil at Silchester, who at present prevented the cemetery there being thoroughly excavated.

On the motion of the Chairman, a hearty vote of thanks was accorded to Mr. Reginald Smith for his interesting paper, and the meeting terminated.

INTERNATIONAL COURSES OF LECTURES ON COMMERCE.

A few years ago the International Association for the Promotion of Commercial Education was founded for the purpose of organising Commercial Courses of Lectures each year in different countries. The offices of the Association are at Berne, and the President is Monsieur A. Junod, Département fédéral du Commerce, Berne.

The Association receives the patronage and the financial support of the Governments of Austria, Baden, Belgium, Brunswick, France, Prussia, Saxony, Switzerland, and Wurtemburg.

The prospectus states that the aim of these courses is:—

1. To demonstrate to the students the economic development of the country in which the course is held, while at the same time studying its manners and customs, and its relations with other countries.

2. To familiarise students with the language of the country.

3. By means of excursions to make known the country and its commercial and industrial enterprises.

4. To create intercourse between persons who, in various countries, deal with commercial questions.

5. To examine thoroughly questions relating to the teaching of the Economic and Commercial Sciences, and those bearing on the study of Modern Languages.

Holiday courses of Lectures for the advancement of commercial studies have been held at Lausanne (1907), Mannheim (1908), Havre (1909), and Vienna (1910). All these were successful and well attended.

It is now proposed to give a similar course in London in July, 1911. The object of the Lectures is to familiarise the students (mainly commercial men and teachers of economics from Continental schools and universities) with the history and practical working of English Commerce and Industry.

The Lectures will be delivered at the School of Economics, Clare Market, W.C., from July 24th to August 12th, 1911. The proposal has received the approval of the Council of the Royal Society of Arts.

Arrangements are now being made for securing the assistance as lecturers of the most eminent British authorities on economic and commercial subjects, and satisfactory promises of help have already been received.

An influential committee is in course of formation, and their names will shortly be announced.

The expenses of the courses are partly defrayed from the funds of the Association and partly by the fees of the students who attend; but it will be necessary to supplement these resources by a local subscription, and an appeal will therefore be made to those interested in the movement to provide a sum of about £400. It is estimated, from the experience of previous meetings, that this amount should suffice to carry out the proposed course in a satisfactory manner.

As soon as possible the list of lecturers and a programme of the course will be published.

In the meantime those interested in the subject are invited to communicate with the Organising Secretary for Great Britain, E. Cleveland-Stevens, School of Economics, Clare Market, London, W.C.

RESCUE WORK IN MINES.

The General Report on Mines and Quarries for 1909 by the Chief Inspector of Mines (Cd. 5,399) contains some interesting particulars of the steps which have been taken recently to encourage the training of men in mine rescue work. These steps are largely due to a desire expressed by the Royal Commission on Mines in their second report, issued in September 1909, "that in each district there should be appointed committees of colliery-owners to provide for the erection of stations and training of men, and that a handbook might be drawn up containing instructions in rescue work, with recommendations as to preparations necessary in case of emergency."

The coal-owners, in reply to this, have evinced an increased desire to meet the needs of the colliery districts in the establishment and organisation of stations for training rescue brigades in the use of breathing appliances and in general mine rescue work. The improvement, however, is much more marked in some districts than in others. Special commendation is given to the system in operation at Howe Bridge rescue station in Lancashire, which is supported by a large majority of Lancashire and Cheshire coal-owners. Yorkshire "has been to the fore in this good work in the past, though no fresh developments have taken place in the county during the year." At Cowdenbeath a station has been established for Fife and Clackmannan, and this will shortly be in full working order; but in the west of Scotland practically no progress has been made during the year.

In the north of England the coal-owners of Northumberland and Durham have secured a site at Elswick, where a rescue station is being erected. Here will be stored all the necessary appliances for the work, including a motor for the rapid transit of the brigade, and a motor fire-engine. It is expected that it will be possible to reach any colliery in the two counties within an hour of receiving a call. The organisation of the Elswick station differs somewhat from that in other districts, "in that there will be an organised band at the central station constantly available, but it will not be confined to miners, advantage having been taken of an offer from Sir W. G. Armstrong, Whitworth & Co., Ltd., to co-operate with the band of sixty-eight men under Mr. Simonds, some of whom will act as instructors in the use of breathing appliances to men sent in from the various collieries."

Rescue stations have also been established at Mansfield for the Midlands, at Aberaman for the South Wales and Cardiff district, and at Crumlin for the Monmouthshire Western Valley collieries, but none have been erected in the coalfields of West Scotland, North Wales, Staffordshire and Warwickshire.

Several types of breathing apparatus are in use at the various stations, and opinions differ as to which is the most efficient. In this connection the report draws attention to the action of the Council of the Royal Society of Arts, who have offered the Fothergill Prize of a gold medal or £20 with a view to encourage research in this direction. A considerable number of entries have been received, and an expert committee, under the chairmanship of Sir Henry Cunynghame, K.C.B., has been for some time engaged in subjecting the various appliances to practical tests.

PAUPERISM.

In his Presidential Address, entitled, "A Statistical Survey of the Problem of Pauperism," delivered at the opening meeting of the Royal Statistical Society, Lord George Hamilton said that to take a year antecedent to 1871, the date of our Education Act and other remedial measures, for comparison with the existing state of things, was to apply a misleading test. There should be, in recent years, not only a reduction of pauperism in the ratio per thousand, but also in the actual number of paupers.

From the Pauper Census of March 31st, 1906, it was found that there were (exclusive of insane) 827,939 paupers, and, while in the whole population there was an excess of women over men of about a million, the excess of women paupers over male exceeded that proportion in every age group. The total number of persons having recourse to the poor law during the year ending September 30th, 1907, was 1,709,436, or 2·5 times greater than the mean of the number relieved on January 1st and July 1st of the same year, those receiving outdoor relief outnumbering those in receipt of indoor relief by more than two to one.

The Poor Law Commission found that the cycles of pauperism coincide in their duration and movement with the cycles of expansion and contraction of trade.

From 1871-96 there was not only a reduction in the ratio of pauperism, but also in the number of persons relieved. Since 1895-96 there had been a large increase in the number of persons relieved, and, though the ratio per thousand had not risen, this was due to the increase of population. It was disquieting to find, however, that the great reduction in the number of children relieved just about counterbalanced the great increase in the number of adult men receiving relief. Since 1891, men had resorted to poor law institutions at earlier ages than formerly. There had been a progressive increase in the number of men over twenty in receipt of relief, but the rate of male indoor pauperism to male population of the same ages was higher in 1901 than in 1891 at every age from forty-five onwards. The rate of pauperism was very high among dock labourers, and, generally speaking, highest in those occupations in which the casual system of employment predominates, while they were lowest among carpenters and plumbers.

Poor law expenditure had, during the period 1871-1906, risen from £8,000,000 to nearly £14,000,000, and, notwithstanding the vast increase in population, the rate per head was now 1*s.* 7*d.* in excess of what it was in 1871. Increased expenditure had occurred under the following heads:—In-maintenance; maintenance of lunatics; workhouse and other loans; salaries and rations of officers (largely due to remarkable improvement both in training and number of nurses in poor law infirmaries). Out-relief had diminished. The increase of expenditure had not resulted in a diminution of pauperism, but, on the contrary, while the increase per head during the last complete cycle, as compared with the previous cycle, was nearly £3 per head, the number of paupers in the incomplete cycle, 1905-6 to 1909-10, was 87,000 more than it was in the cycle of 1888-89 to 1895-96.

In the counties pauperism was highest in the east and centre of England, and lowest in the north. In London the number of paupers had increased by 36,000, the ratio had risen from 20·5 to 25·1, and the number of adult men maintained in institutions was greater than in any other part of the country. The general workhouse, while it had placed many heavy burdens upon the rates, had, from the deterrent side, been a failure. As regards children, while it was satisfactory to know that there had been a reduction in the total number of children receiving relief, it had to be borne in mind that the reduction had chiefly been in the number of widows' children, while the number of children of able-bodied parents receiving relief had increased. Least progress appeared to have been made in regard to able-bodied paupers. Vast improvement had been made in institutions for the sick during the last twenty-five years.

Taking the figures as a whole, they were most unsatisfactory, not only as regards the number of paupers in receipt of relief, but also in the development of pauperism in recent years which they indicate. The growth of expenditure was shown to be enormous, although coincident with this increased outlay upon poor law there had been a heavy and continuous increase of expenditure, both in education and sanitary reform. We were certainly now spending upon these three objects, in England alone, forty millions a year more than we did at the commencement of the period, 1871-1906, and yet, at the conclusion of that time, we had more paupers than we had at the time before we embarked upon this increased expenditure. We, the richest nation in Europe, have the heaviest pauperism, yet the more we spend the worse the position seems to be.

ARTS AND CRAFTS.

Metalwork.—It is always a relief at this time of year to visit St. Dunstan's Studio, Seymour-place, South Kensington, and see the little exhibition of work by Mr. Omar Ramsden (who recently received the Society's silver medal for his paper, "Silversmiths' and Goldsmiths' Work") and Mr. Alwyn Carr. Their work is really artist craftwork and not the very inferior article that, especially towards the end of December, too often masquerades as such. The real interest of the collection centres in the numerous important pieces of work executed as commissions by the artists during the past year, and either not yet delivered to the purchasers or kindly lent by them.

Amongst the objects carried out in iron, bronze, and brass, the wrought-iron candlestick for Holy Trinity, Sloane-street, the facsimile of a Grille for the Sacrament House of the Church of St. Philip and St. James, Oxford (in pierced brass with a very satisfactory rendering of the Pelican in her piety), and above all, the Treasury Grille and book-rest in bronze for Cape Town Cathedral, merited special attention. The Grille in particular is a very vigorous bit of bronze-work, and the shields of arms which bear so considerable a part in its design (it is evidently a memorial to the troops who fell in the South African War) are most happily planned.

The most prominent feature of the exhibition, however, was the Processional Cross in wrought silver, fire gilt, for St. Peter's, Eaton Square. The arms of the cross are of mother-of-pearl, and the pierced silver renderings of the Evangelists at their extremities and the Agnus Dei in the centre, together with the wreath of ornament, representing the vine on one side and the wheat on the other, which connects the four members of the cross, forms not only a very harmonious bit of design, but a really beautiful and rather subtle colour scheme. The vine and wheat ornament has a very close affinity to the design of the monstrance for the Westminster Cathedral carried out by the same artists some years ago, but it is, as a design, none the worse for that. Another interesting bit of work was the seal for the Bishop of St. Andrews. The bishop is represented in full canonicals, in the act of benediction, and the long, regular folds of the drapery and the dignified pose help to make the seal the thoroughly satisfactory whole that it is. The lettering of the border, too, is just the right weight to balance the figurework and hold it in its place. The morse in hand-wrought gold, enamel and jewels was another interesting piece of ecclesiastical work.

Amongst objects destined to secular uses may be mentioned a drinking-horn, mounted in silver with an ebony base supported by the Pendragon, and a tankard with a lid bearing a conventional design of hops. The two-handled cup and cover to be presented to an eminent mining engineer is interesting as an attempt to render ornamentally a conspicuously modern theme; whilst the standard salts designed respectively for the Worshipful Company of Apothecaries and the Worshipful Company of Haberdashers, are purposely late Renaissance in character in order to be in keeping with the other plate belonging to the companies. They are quite adequate to their purpose but they are, as one would naturally have expected, far less characteristic and individual than most of Messrs. Ramsden and Carr's work.

Home Arts and Industries.—The Winter Exhibition of the Home Arts and Industries' Association is always on a smaller scale than that held in the summer, and, since it is intended primarily to attract the buyers of Christmas presents, it consists chiefly, though not entirely, of the smaller, and in a sense less important, kinds of work. It has, however, in some respects an advantage over the larger show. As there is less to be seen it is easier to see what is on view, and easier, too, for the officials of the Association so to place and group the stalls that exhibits of one kind are to be found more or less in the same place. It speaks well for the influence of the Association and for the strength of will of the class-holders that a show held near Christmas time with the avowed object of catering for the Christmas market should be as good as this undoubtedly was. Of course one or two of the stalls were covered with work which was by no means satisfactory, but on the whole a very creditably high standard was maintained. It is, of course, difficult in an Association of this kind to draw hard-and-fast rules, but one could have wished that a larger proportion of the exhibits had come from the ranks of the ordinary classes, rather than from those of what are called at the summer exhibition "partially-developed" or "developed" industries, some of which have little to distinguish them from ordinary commercial undertakings.

There was not a very large show of metalwork, but the exhibits sent from Keswick were quite satisfactory—sufficiently severe in form and well executed. Pottery was represented by figures and vases produced by the Compton Potters' Art Guild, with which Mrs. Watts is associated, and a small collection of Mr. Howson Taylor's pots. There was an exhibit of good though very modest leatherwork from Failand, Bristol, and the Fine Needlework Association sent some very dainty smocking, often carried out in very pretty colours. The most interesting embroidery, however, came from the north. Windermere sent some work in which an eminently satisfactory effect was produced without any waste of labour and was remarkable, as usual, for its bold and tasteful colouring. From Langdale came a very fine show of cut work, good both in design and execution. The success of the few pieces in blue and white ought to encourage the workers to try some more ambitious combinations of colour. The handloom weaving was largely craft pure and simple, with no pretensions to art; but there were some beautifully-coloured silks from Windermere, and the very simply-patterned woven

fabrics made at the Barclay Workshops for the Blind were in very good taste. This kind of weaving makes trimmings which are often more suitable to their purpose than embroidery. The so-called "Colonial mats," woven by the Dun Emer Guild, are in reality a very attractive version of the old-fashioned rag carpet; but the colours employed are so harmonious, and withal so clean-looking, that we hardly recognise our well-known and very dowdy old friend in her new dress.

Lace.—It was, however, in lace that the largest and most representative show was made. The lace exhibits were almost all arranged in a room by themselves, and they gained considerably by their isolation. Lace takes so much looking at that it is apt to be passed over when surrounded by work which catches the eye more readily. It was quite evident from the display made that, whatever may have been the case some years ago, at the present time there is no danger of the hand-made lace industry dying out in England. The revival seems to have affected not only one county or group of counties, but the country as a whole. English lace is a trifle dearer than that made abroad, for the standard of living is happily higher over here; but, except for motives of economy, there is really very little reason nowadays why people should buy Continental laces rather than those made at home. Quantities of lace are being made in these islands, not only Honiton, Buckinghamshire, Tambour, Limerick and Carrickmacross, but also the rather coarse kinds of Italian lace which are so popular in this country. The main centres of the industry are naturally (so far as England is concerned) Devon and Bucks, but some very good Honiton lace is being made in Norfolk, and Tambour lacemaking has for generations been carried on in Essex.

A good deal has been said in the past, and with every show of reason, about the poorness of the modern lace designs and the unintelligent way in which the traditional ones are too often copied; but it seems as though the efforts made by various individuals and societies in recent years to improve the quality, both of the workmanship and the pattern, are at last bearing fruit. There was nothing very remarkable in the way of design to be seen at Park Lane last week, but there was a good deal of work which was well balanced, well adapted to lace, and quite sufficiently attractive, and much less of the rather aimless and meaningless work that was so common only a couple of years ago. The advance is peculiarly noticeable in some of the Honiton lace exhibited, and is perhaps more marked in the pillow lace generally than in the needle-point.

The copies of old Italian metal laces from Kingston Bagpuize and Longworth, are always interesting, and the coloured silk lace is also satisfactory; but it looks as though more might be done in the way of silk lace with a certain amount of metal introduced. The difference in elasticity of the two materials may perhaps make this lace more difficult to work, but it ought to be possible to get lace which is not only effective but durable from the combination of the two kinds of thread.

EMPIRE NOTES.

British Trade Commissioners.—The visit to this country next year of the British Trade Commissioners, who were appointed by the Board of Trade to represent it in Australia and New Zealand, is likely to be of considerable interest and great service to the commercial and industrial community in the United Kingdom. The object of the Board, in arranging the visit of their representatives, is to afford to the manufacturers and merchants of London and the provinces the opportunity of consulting them on the general conditions of trade in the Australian States and in New Zealand, and of the openings there for British goods. Chambers of Commerce, and other representative commercial associations throughout Great Britain and Ireland, are being invited by the Board of Trade to arrange for these visits. It has been suggested that Mr. Richard Grigg, the British Commissioner in Canada, who has done such excellent work there, should join them. Mr. Grigg has made a close study of the industrial and commercial interests of the Dominion, and is well qualified to advise home manufacturers and merchants as to the prospects of trade in that country.

Canada and British Capital.—The field afforded in Canada for the investment of British capital has been pointed out in these columns on more than one occasion, but the subject is so important that any new light upon it is gladly welcomed. Mr. R. B. Angus, President of the Bank of Montreal, at a recent shareholders' meeting, emphasised the fact that the large influx of settlers into the Dominion, with their varied and ever-expanding needs and demands, combined with the enormous development work now in progress, offered continual opportunities to capitalists. "I am safe in saying," he declared, "that the Dominion as a whole has enjoyed a good degree of prosperity throughout the year, and that no doubt need be entertained regarding its continued growth in wealth and population in the future."

Canadian Progress.—During his recent visit to Canada, Mr. T. P. O'Connor, in the course of a series of addresses in various parts of the Dominion, said: "I have had the opportunity of seeing the great West, and all I heard and read of that wonderful region fell infinitely below what I found there. The boundless open prairie of the best wheat land in the world, through which I passed for days, revealed to me the notable fact that in Canada you have the greatest possession yet unconquered by the people and labour of the world. It is a veritable El Dorado, not requiring toil or peril of the ordinary experiences of the pioneering

settlement and cultivation, but just holding out its precious and boundless bosom to all in the world who have courage, enterprise, and hands which are willing to pick up its treasures. I found side by side with this feverish industrial activity a spirit of law-abidingness, of order, of sanity, which are the best qualities of the British character and of British institutions, and I am old-fashioned enough to feel that without this combination of restless activity and of stable society the present Canada would not be so attractive nor the future so hopeful."

Western Australian Finance.—Western Australia has been making great progress in all directions during the past year. The report of the Premier's budget speech is regarded as most satisfactory. The transactions of the previous twelve months realised a surplus of £209,000, thus reducing the deficit accumulated in former years to £102,000. The estimates of revenue and expenditure for the succeeding year show a balance which would not only extinguish the existing deficit but yield a surplus. The forecast is considered a safe one in view of the rapid advance of all industries. The speech reveals many interesting points in the State Trades' Account, concerning the railways and other reproductive public works, which, after allowing for working expenses, show a credit balance of no less than £753,802 for the year. As the interest and sinking fund payable on the public loans of the State (£22,000,000) amount to £759,443, all that the tax-payer will be obliged to pay to meet this demand will, on the present year's basis, be a trifle over £5,000 per annum. This fact is an assurance to the holders of Western Australian Stock of the soundness of their investment, and should be a guarantee of the financial standing of this progressive Australian State.

The Mono-Rail in Australia.—For many months past the mono-rail system has been a subject of discussion throughout Australia, and experiments have been carried out to test its utility as a means for securing cheap and reliable transportation. South Australia is now considering the advisability of adopting it in some parts of the new agricultural districts which are being opened up, as the cost of making roads is heavy. A special mono-rail truck is being constructed by the Government for this purpose, which promises to be a success. The estimated cost of a railway of this character is about £500 per mile, including rolling-stock. A useful example of how the mono-rail works is to be found in the forests of Burma and Siam, where elephant traction is used to convey the heavy logs of teak and other timbers to the mills or the waterways.

South African Products Exhibition.—In the spring of 1912 it is proposed to hold a South African Industrial, Agricultural and Products Exhibition at Maritzburg, Natal. It is considered that such an opportunity to attract the attention of the world's investors, financiers and buyers would be welcomed, not only by residents of that city, but by the commercial and industrial classes of South Africa generally, and that the exhibition would be of great service to the Union. Many reasons are advanced in favour of the selection of Maritzburg, as its climate, in the spring especially, is ideal, and its situation, right in the heart of the garden province, is not only one of the most beautiful in South Africa, but is easily accessible by rail and sea.

New Zealand: Preservation of the Huia.—The huia, one of the rare birds peculiar to New Zealand, is becoming rapidly extinct. In order, if possible, to prevent its utter extinction, a scheme is now on foot to find odd specimens of the breed, catch them, and place them on one of the island sanctuaries of the coast. Two Maori trappers are to be despatched to the head-waters of the Kawatau stream, a tributary of the Rangitikei River, also the head-waters of the Mangawharariki and Pohangina Rivers. It is proposed that the expedition should search round the head-waters of these rivers and along the foothills of the Tararua range. The huia is a jet-black bird, with a white band at the extreme end of its tail feathers. The feathers of these birds are much valued by the aboriginals; no Maori of importance considers himself becomingly dressed unless one or more huia feathers form part of his head-dress.

An Important Radium Discovery.—Professor Douglas Mawson, an eminent Australian scientist, who accompanied Sir Ernest Shackleton on his recent expedition to the Antarctic, made an important announcement at the last meeting of the Royal Society of South Australia. He exhibited a specimen of pitch-blende, which he had found in the course of his researches at Olary, 257 miles to the north of Adelaide. The pitch-blende discovered in this locality is a surface film, found in the cracks of the rocks. Near the surface of the ground the film is coloured yellow by the presence of Carnotite. The discovery is of greater scientific than commercial value, but is specially interesting on account of its being the first authentic find of pitch-blende in Australia. Radium, however, has been known to occur in Western Australia and Tasmania.

GENERAL NOTES.

PHYSICAL SOCIETY OF LONDON.—The Annual Exhibition of Physical Apparatus will be held on Tuesday, December 20th, 1910, in the afternoon from 3 to 6 p.m., and in the evening from 7 to 10 p.m., at the Imperial College of Science, Imperial Institute-road, South Kensington. At the exhibition a discourse on some improvements in Transmitters and Receivers for Wireless Telegraphy will be delivered by Professor J. A. Fleming, M.A., D.Sc., F.R.S., and cinematograph demonstrations of some physical phenomena will be given at intervals by Mr. R. W. Paul.

THE ENCYCLOPÆDIA BRITANNICA.—Speaking at a recent dinner to the contributors to the Encyclopædia, Mr. Hugh Chisholm, the editor, referred to the amount of practical work which the eleventh edition involved. It contained 50,000,000 words, equal to 500 ordinary books of 100,000 words each, and all of that had to be read by the editorial staff at least ten times before it assumed its final form. Considered from the industrial point of view, the eleventh edition was of great importance. It entailed the production in fourteen or fifteen months of one-half again as large an edition as the ninth, which took fourteen or fifteen years to produce. To take the India paper edition only, the actual number of volumes which would be produced in the next six months would be 1,000,000, the equivalent of 17,000,000 ordinary books, a fact which, from the industrial point of view alone, possessed some interest. The world's annual production of India paper was only 200 tons. The producers of the "Encyclopædia Britannica" gave an order for 2,000 tons, and mills in every civilised country, with the exception of the United States—where the paper could not be manufactured—had to be started to make the paper, so that the production of the Encyclopædia was a factor of some importance to industry.

POTATO STARCH-MAKING IN GERMANY.—Potatoes are the principal source of the starch manufactured in Germany, and that potato starch—known as "Kartoffelmehl"—enters extensively into the German export trade. The potatoes are first thoroughly washed, and then mashed between heavy rolling cylinders, on the surface of which there are grooves and teeth to tear up the potato cells. The starch is washed out of this ground-up pulp by means of running water. The resulting so-called "starch milk" is first drained through wire or silk screens or through perforated copper plates to remove the cell pulp, after which it is allowed to flow directly into cement settling vats or caves, or it may first be led over small, gently-sloping troughs or drains, upon which the purest of the starch then settles. The starch from the settling vats and from the settling drains is refined by being rinsed in stirring vats, and the impurities and cell substances are skimmed off. The water is then removed by special centrifugal hydro-extractors, and the resulting so-called "green starch" is generally worked up into dextrin and sugar. For producing the starch of commerce, it must be further dried in specially constructed drying chambers. The potato pulp or cell stuff, left over, is subjected to a renewal of the refining process, or it may be dried and used as cattle food.

POTATO-MEAL IN INDIA.—The development of new industries in India is always interesting, and the experiments in the manufacture of potato-meal made by Colonel Rennick, a Kulu planter, in the hills beyond Simla, have now become a practical success, the army authorities having already purchased several thousand tins as emergency army rations. Colonel Rennick has recently transferred his operations from Kulu to Narkanda, a village some forty miles beyond Simla on the well-known Hindustan and Tibet road, constructed by Lord Dalhousie about half a century ago, with the object of fostering trade with Tibet. Machinery has been procured from England, and the various buildings, works, and barracks are now approaching completion. The spot is in the centre of a tract under potato cultivation with a radius of about ten miles, while firewood is obtainable from an extensive forest called Baghi, and the railway is at a convenient distance. The potatoes, after being boiled, and peeled by hand labour, are then crushed by the engine-driven machines, prepared by a patent process, and packed in hermetically-sealed tins, each containing a pound of meal, which will cost about a rupee, and serve roughly for a week's consumption—two ounces being more than sufficient for a good meal. As a new and useful addition to the kitchen stores, it is anticipated that the potato-meal tin will find favour in many a camp.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DECEMBER 19...Bibliographical, 20, Hanover-square, W., 5 p.m. Mr. S. H. Scott, "Martin, Peter and Johann Schott, of Strasburg."

Geographical, in the Theatre, Burlington-gardens, W., 8.30 p.m. Dr. J. B. Charcot, "The French Antarctic Expedition, 1909-10."

London Chamber of Commerce, Oxford-court, Cannon-street, E.C., 2.30 p.m. Señor M. Zamacona, "The Economic Development of Mexico and the Possibilities of Extending British Trade with that Country."

TUESDAY, DECEMBER 20...Geographical, in the Theatre, Burlington Gardens, W., 8.15 p.m. Professor P. Geddes, "Inland Towns and Cities: their Main Origins." (Lecture II.)

Civil Engineers, Great George-street, S.W., 8 p.m. Mr. A. E. Carey, "The Winning of Coastal Lands in Holland."

Statistical (at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 5 p.m.

Photographic, 35, Russell-square, W.C., 8 p.m. Dr. W. Scheffer, "The Present State of Microscopic Research with Regard to Dry Plates."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mr. J. Buckland, "The Birds of the Colonies and their Preservation."

WEDNESDAY, DECEMBER 21...Meteorological, 25, Great George-street, S.W., 7.30 p.m. 1. Captain C. H. Ley, (a) "Report on Balloon Experiments at Blackpool, 1910." (b) "The Meteorological Significance of Small Wind and Pressure Variations." 2. Dr. Wilhelm Schmidt, "Atmospheric Waves of Short Period."

Geological, Burlington House, W., 8 p.m. 1. Mr. T. O. Bosworth, "The Keuper Marls of the Charnwood District." 2. Mr. R. L. Sherlock, "The Relationship of the Permian to the Trias in Nottinghamshire."

Microscopical, 20, Hanover-square, W., 8 p.m. Mr. Arthur Earland, "Modern Methods of Research on a Scientific Cruiser."

Mining and Metallurgy (at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.), 8 p.m. 1. Mr. F. Gillman, "Malaga Magnetites." 2. Mr. R. W. Hannam, "A Method of Raising Bore-Casings from a Pontoon." 3. Mr. H. C. Bayldon, "Notes on Chilian Mills in Russia."

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FRIDAY, DECEMBER 23, 1910.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be delivered on Wednesday afternoons, January 4th and 11th, at 5 o'clock, by ARTHUR MASON WORTHINGTON, C.B., M.A., F.R.S., Professor of Physics in the Royal Naval Engineering College, Devonport, on "A Study of Splashes, conducted by the aid of Instantaneous Photography."

Each Member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to Members in the order in which applications are received.

Members who desire tickets for the course are requested to apply for them at once.

COVERS FOR JOURNALS.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1*s.* 6*d.* each, on application to the Secretary.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

INDUSTRIAL PYROMETRY.

By CHARLES R. DARLING, A.R.C.Sc.I., F.I.C.

Lecture I.—Delivered November 21st, 1910.

The science of temperature measurement, from the time of its inception in the seventeenth century to the present day, has proved of inestimable service to mankind. Commencing with crude instruments intended to indicate the hotness of the human body, the scope of thermometric appliances has gradually been extended by successive discoveries until, at the present time, we are able to express the temperatures of the coldest and hottest terrestrial conditions, ranging from frozen helium to the electric arc. With a less degree of certainty, we are even able to estimate the temperature of the sun, which greatly exceeds in hotness any artificial source of heat at our disposal. In the present lectures we shall only be concerned with the measurement of the range of temperatures above the limit of a mercury thermometer; and any instrument designed to indicate such temperatures we shall term a "pyrometer." Although such instruments have been in use for over a century, it is only within recent years that reliability and precision have been attained; and the perfecting of pyrometers has led to results of the highest value in many industries. Not only have many processes been improved as the outcome of researches conducted with the aid of accurate pyrometers, but, in addition, it has become possible to carry out operations at the exact temperature found by trial to give the best results. All the benefits which accrue from definiteness and certainty, as opposed to haphazard, may now be secured in furnace processes by the use of accurate pyrometers.

A brief survey of the history of the subject will form a fitting preface to the study of modern pyrometers; and it would be difficult to discover any branch of science which better illustrates the triumph of patient research over seemingly insuperable difficulties. The first attempt to record the thermal condition of a fire in terms of degrees on a thermometric scale was made by Sir Isaac Newton in 1701. A bar of iron was heated in the fire, and then removed and allowed to cool under uniform conditions. Small pieces of tin and other substances, the melting points of which had previously been determined by Newton with a linseed-oil thermometer,

were placed upon the bar, and the time taken by the bar to cool down from a red heat to the melting point of tin was noted, and also the time which elapsed between the congealing of the tin and the substances of lower melting points. Assuming that the rate of cooling of the bar was proportional to its excess temperature over its surroundings, and knowing the times and temperatures corresponding to the solidification of the substances placed on the bar, Newton calculated by extrapolation the original temperature of the bar from the time taken to cool down to the melting point of tin. The figures obtained, translated into Centigrade degrees, were 565 for a small coal fire and 620 for a fire in which wood was burnt. The law of cooling assumed by Newton we now know to be inaccurate; nevertheless these figures were much closer to the true value than those current a century later. There is no record of Newton's method having been applied in the arts for measuring furnace temperatures, for which purpose it is ill-adapted; but it is interesting to note that one of the most recent forms of pyrometer is based upon the more accurate relation since discovered to exist between the temperature of a solid and the quantity of radiant energy emitted by it. To Newton, therefore, is due the credit of first extending the thermometric scale into the region of visible heat.

It was not until 1782, however, that a practical instrument for measuring the thermal condition of a furnace, with a view to proper control, was invented. In this year Josiah Wedgwood, the famous potter, introduced a pyrometer based on the permanent contraction undergone by clay when fired, and was able, by the aid of this contrivance, to control the temperature of his furnaces more closely than had hitherto been possible. Wedgwood had found that all the care expended in the selection and working-up of his materials might be completely nullified unless the firing were conducted at the correct temperature, and had also discovered that the eye of the best-trained workman could not be trusted to judge the working temperature to the required degree of accuracy. Having observed that the amount of the permanent contraction experienced by clay when fired increased with the temperature, Wedgwood constructed a tapered gauge (Fig. 1), made in two portions, each 6 in. long. At the widest part, opposite the zero division, the width of the groove was 0·5 in., whilst the narrowest portion, which was marked 240, possessed a width of 0·3 in. Cylinders of a special clay, moulded with a flat part to rest on the bottom of the groove, were prepared, and were made of such size that, after drying, the diameter was 0·5 in. or nearly so; and hence such cylinders, when pushed down the gauge, came to rest near the zero mark. The length of the groove was divided into 240 equal parts, each 0·05 in. long, which were called "degrees." In order to test the condition of the furnace, one of the clay cylinders was introduced, and allowed

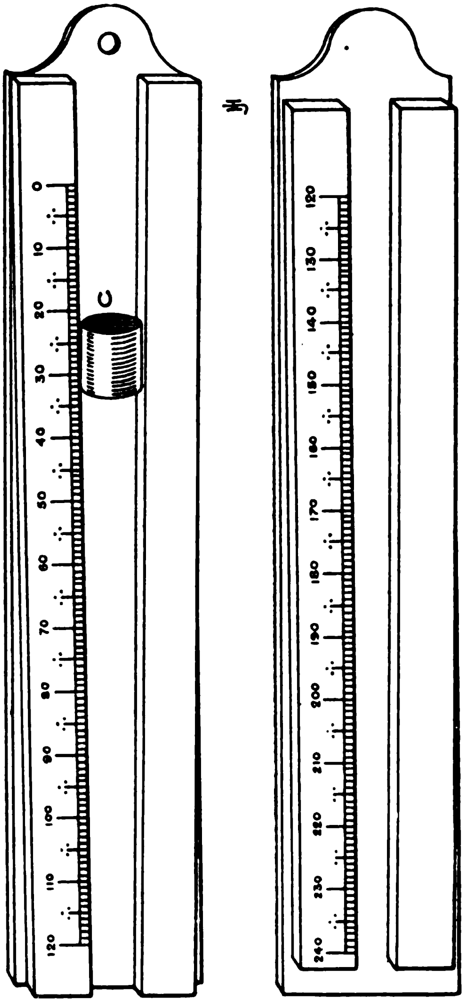

Fig. 1.—Wedgwood's Pyrometer.

to remain for a specified time; it was then removed, and, after cooling, inserted in the gauge, when the number opposite the forward end indicated the temperature in terms of Wedgwood's scale. As the correct degree for the work in hand had been discovered by previous trials, the reading obtained could be used to regulate the furnace until the proper temperature had been attained. There is little doubt that

Wedgwood's great success as a potter was largely due to the correct adjustment of his working temperatures; and time has paid a tribute to the utility of his method, which for nearly a century held undisputed sway, and has not even yet been entirely supplanted.

Wedgwood made an attempt to express the arbitrary degrees on his scale in terms of the accepted Fahrenheit degrees, and concluded that each degree was equal to 130° F. He assigned to the melting point of silver the value 4,717°, and to molten cast-iron 17,977°. These and other similar figures were generally accepted, and in tables published early in the nineteenth century the melting point of wrought-iron was recorded as 21,637° F., or 12,001° C. Considering that modern observations point to the vicinity of 1,500° C. as the correct figure, the introduction of the unit in the value 12,001 appears somewhat grotesque. The accuracy of these figures was first challenged by Daniell, who in 1822 published an account of a pyrometer based on the expansion of a platinum rod encased in a plumbago tube. Assuming the expansion of the platinum, relative to plumbago, to be uniform, Daniell obtained the figures 2,233° F. and 3,479° F. respectively for the melting points of silver and cast-iron—a difference in the latter figure of over 14,000° from that given by Wedgwood. Both these observers used the mercury thermometer for the first stages of the calibration, and assumed that the relation obtained at low temperatures held for higher degrees on the scale. The necessity for some accurate standard of temperature, with which all pyrometers could be compared and brought into agreement, thus became manifest at this early stage in the development of the subject.

Time will not permit of a detailed history of the progress of pyrometry from the time of Daniell to the present day, and only the salient features will be noted. In 1822 Seebeck discovered that if a junction of two different metals, forming part of a closed electric circuit, be heated, a current of electricity is produced in the circuit. I show this effect by taking two pieces of wire, one of iron and the other of nickel, joined at one end, and the free ends connected to a galvanometer, the moving part of which is furnished with a mirror from which a spot of light is reflected on to a scale. On placing the junction in a flame, the spot of light immediately moves along the scale, and it will be noted that the distance moved increases as the junction becomes hotter. Becquerel, in 1826, proposed to apply this phenomenon to the measurement of high temperatures, but was unable to obtain concordant results; and this experience was shared by others who afterwards worked in this direction. The cause of the early failures, and the manner in which the Seebeck effect has been successfully applied in recent times, will appear subsequently. Pyrometers based on the expansion of a gas were first suggested by Prinsep in 1828; the calorimetric method, in which the temperature of a hot substance is determined by dropping it into a known quantity of water, and noting the rise in temperature produced in the water, was patented by Byström in 1862; the optical method, in which temperature is deduced from luminosity, was first applied by Ed. Becquerel in 1863; and the resistance method, based on the increased resistance offered to electricity by a metal when heated, originated with Sir W. Siemens in 1871. All these methods are utilised at the present time.

Prior to 1886, however, pyrometers were little used in the industries, mainly for the reason that a sufficient degree of accuracy had not been attained in their indications to impress upon manufacturers the advantages to be derived from using them. The perfecting of the thermo-electric method by Le Chatelier in the year named, furnished a means of regulating high temperatures with great precision, the advantages of which were quickly recognised. In no branch of the arts is the exact adjustment of temperature of greater importance than in the working of steel, and it was to this purpose that Le Chatelier's pyrometer was first applied. In this connection, I wish to show an experiment which clearly demonstrates a remarkable property of iron and steel. Stretched across the room is an iron wire, which we will raise to a white heat by passing a powerful electric current through it. The wire, expanded by the heat, droops in the centre, and when we switch off the current, and allow the wire to cool, you will notice an interruption during the contraction and straightening of the wire. You observe that at first the wire contracts, and the centre rises; but suddenly, whilst the wire is still visibly red, it droops again, owing to a spontaneous rise in temperature which causes it to elongate; and then it straightens out gradually until cold. We might, by warming up the wire slowly, observe the same effects in converse order. If we repeat this experiment with a wire of copper, or nickel, or platinum, we notice that the cooling proceeds uniformly, and shows no break in the passage from the curved form to the straight. Professor

Barrett, who discovered this phenomenon nearly half a century ago, applied to it the term "recalescence," from the fact that the iron or steel becomes hotter without external assistance. When a large block of iron or steel is used instead of a wire, the sudden rise of temperature may easily be detected from the increase in brightness. It is a remarkable fact that none of the vast number of men engaged for centuries in the fabrication of steel articles ever observed —or at any rate recorded—this curious change, thus vindicating literally the truth of Da Vinci's aphorism, that "it is only the eye of knowledge which sees." The anomalous behaviour of iron and steel in this connection indicates that at the temperature of recalescence the internal structure of the metal is profoundly modified, resulting in the disengagement of energy in the form of heat. Other evidence of this change of structure is found in the fact that above the recalescence temperature iron is non-magnetic, but is powerfully attracted by a magnet immediately after the change has occurred. The case of steel is not so simple as that of iron, owing to the presence of carbon and other ingredients, and two or more points at which the cooling is arrested may be noted. Steel differs from iron in being capable of hardening and tempering, and these two properties are closely associated with the molecular change we have noticed. It has been found by Sir Robert Hadfield, for example, that a sample of steel containing 1·16 per cent. of carbon, when heated to a temperature just below the change point, is not hardened when quenched; but when heated a further 15° C. or 27° F. before quenching, becomes totally hard. Here is a case where the difference of a few degrees, which would escape detection by the most skilful eye, is of vital importance in determining the character of the finished product.

It will readily be seen from these considerations that an exact instrument would be of great service in the steel industry, and consequently Le Chatelier's pyrometer soon came into practical use. By its aid tests could be carried out at various temperatures which could be reproduced with certainty, and new methods of heat treatment were thus discovered. Other industries were not slow to recognise the value of precise temperature control; and every year since 1886 has seen the continued extension of the use of pyrometers. Various new instruments have been invented and found a successful application, until at the present day the manufacture of pyrometers has become an important industry in itself. Now, it is evident that all pyrometers, of any pattern, ought to give identical readings under the same conditions of temperature; and this entails the use of a standard of reference. The best practical standard is furnished by the "gas" pyrometer, as its readings are in close conformity with the absolute or thermodynamic scale of temperatures. We are able, by means of measuring the increase in volume or pressure of a gas to obtain a scale of temperatures, which we shall call the "gas scale." If, for example, we measure the volume of a gas such as hydrogen when surrounded by ice, and also when surrounded by steam at 760 mm. pressure, we find the ratio of the two volumes to be expressed by the fraction $\frac{273}{373}$. If we agree to call the temperature interval between ice and steam 100° C., we may state that the gas expands by $\frac{1}{273}$ of its volume at 0° C. for each degree rise in temperature. We may extend this scale indefinitely; thus the temperature at which the volume is doubled would be 273° C., when trebled 546° C., and so on. This procedure would be difficult to carry out in practice, and we may instead rely upon the fact that if the gas be prevented from expanding its pressure increases, so that at 273° C. the pressure is double that exerted by the gas at 0°, and at 546° C. three times as great. This is the principle of the constant volume gas thermometer, in which the gas is prevented from expanding by raising a cistern of mercury, the height of the column of mercury thus becoming an index to the temperature of the gas by measuring its pressure. In applying this instrument to the measurement of high temperatures, it must possess a bulb which is not distorted by heat, even under high pressures, as otherwise the volume would alter and consequently the pressure. In its latest form the standard gas pyrometer is furnished with a bulb made from an alloy of platinum and rhodium, containing 20 per cent. of the latter metal. In order to prevent distortion at high temperatures, the bulb is enclosed in a space in which the pressure is maintained at the same extent as that of the gas in the bulb. Nitrogen gas is used as the thermometric substance, as hydrogen escapes through hot platinum. By the aid of this instrument temperatures as high as 1,550° C. may be read with certainty; but beyond this point the bulb becomes too soft and alters in shape by its own weight. The gas pyrometer described, however, is too cumbersome for everyday use in the workshop, and is only employed to fix standard points for the calibration of more convenient instruments. It

is merely a standard of reference, which enables all other pyrometers to be made to agree in their readings. In order to give practical effect to this standardisation, a number of fixed points have been determined with great precision by various observers. These are indicated in the table before us :—

until at the present day we have reason to believe that the greatest possible error on the gas scale, at 1,550° C., is not greater than 2°, and that pyrometry, therefore, may claim to rank as an exact science.

I now pass on to a description of the various pyrometers in use at the present time, and

TABLE OF FIXED POINTS.

Substance.	Physical Condition.	Deg. Centigrade.	Deg. Fahrenheit.
Water (ice)	At Melting Point	0	32
Water	,, Boiling ,,	100	212
Aniline	,, ,, ,,	184	363
Naphthalene	,, ,, ,,	220	428
Tin	,, Melting ,,	232	249
Lead	,, ,, ,,	327	620
Zinc	,, ,, ,,	419	786
Sulphur	,, Boiling ,,	445	833
Antimony	,, Melting ,,	632	1169
Aluminium	,, ,, ,,	657	1214
Common Salt	,, ,, ,,	800	1472
Silver (in air)	,, ,, ,,	955	1751
Silver (free from oxygen)	,, ,, ,,	962	1763
Gold	,, ,, ,,	1064	1947
Copper (in air)	,, ,, ,,	1064	1947
,, (Graphite covered)	,, ,, ,,	1084	1983
Iron (pure)	,, ,, ,,	1507	2744
Palladium	,, ,, ,,	1540	2804
Platinum	,, ,, ,,	1753	3187

In making a temperature scale for a pyrometer of any kind we are at liberty to take any suitable fixed points from the table, and, having inserted the pyrometer in the substance and allowed the physical state specified to be realised, we may mark the scale of the pyrometer with the temperature indicated for the substance. We may thus obtain a number of points on the scale of our instrument, and afterwards subdivide the space between the points in an appropriate manner. All pyrometers may thus be made to agree with each other and with the gas scale. It must be remembered that above 1,550° C. direct comparisons with the gas scale are not yet possible, and any value exceeding this is derived by a process of extrapolation, and possesses the uncertainty which always attaches to such procedure.

I have thought it advisable to deal thus early with the method of standardising pyrometers, in order to emphasise the fact that only by reference to a single accepted standard can all the various types be brought into harmony. The figures used in the workshop are thus the product of years of patient labour in the research laboratory, by means of which the discrepancies of gas pyrometers have been eliminated one by one,

propose to give an account of the underlying principle in each instance, and to mention the special uses and limitations of each type. And in order to clear the way for the examination of the more complicated patterns, we will deal first of all with a miscellaneous set of devices of a simple character which are found useful in numerous operations. We will commence with

CALORIMETRIC OR WATER PYROMETERS.

When a metal of known weight and specific heat is raised to a high temperature and plunged into a known quantity of cold water, the rise in temperature of the water may be used to calculate the original temperature of the piece of metal. If, for example, 100 grams of a metal of specific heat 0·1 were taken from a furnace and dropped into 500 grams of water at 5° C., which thereby becomes heated to 25° C., we may proceed by equating the heat lost by the metal to that gained by the water, thus :—

$$100 \times \cdot 1 \times (t - 25) = 500 \times (25 - 5)$$

and t, the temperature of the hot metal, is 1,025° C.

I have here the earliest instrument of this type, as made by Byström. It consists of a

zinc vessel, lagged with wood, to hold the water; and a metal cage, dipping under the water, to contain the lump of hot metal, which was a piece of platinum. A thermometer, passing through a hole in the lid, served to indicate the rise in temperature. This instrument was in use in the Royal Arsenal, Woolwich, in 1863. A later type, which is shown in the diagram

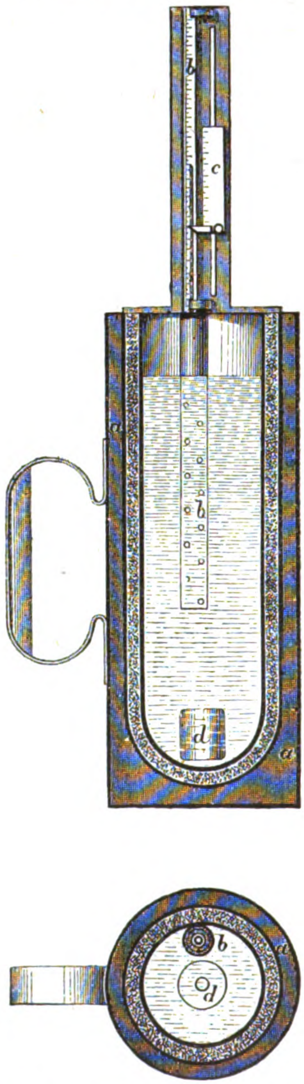

Fig. 2.—Siemens' Water Pyrometer.

(Fig. 2), and of which we have an example on the lecture table, is now sold by Messrs. Siemens Bros. and Co. The water is contained in the inner of two concentric vessels, the space between being filled with non-conducting material, and the outer vessel furnished with a handle for convenience in holding. Cylinders of metal, of known weight, are provided; copper, iron, or nickel being available according to the wish of the user. To avoid the necessity of calculation, a scale is fixed at the side of the thermometer, from which the temperature of the hot metal may be read off by noticing the mark opposite to the top of the mercury column in the thermometer after quenching. In this form the water pyrometer may be used by workmen unskilled in calculations, and the manipulation is of the simplest character.

We will now consider how the temperatures indicated by the water pyrometer may be made to agree with temperatures on the standard gas scale. As will be noted from the calculation, everything depends on an accurate knowledge of the specific heat of the metal used; and as the specific heat of metals generally increases as the temperature rises, it is necessary to know this value accurately for the range comprehended by the instrument. Numerous experiments, conducted at various temperatures measured on the gas scale, have furnished the information required; and by using the figures thus obtained in marking the temperatures on the scale of the pyrometer, an instrument based upon the accepted standard is secured.

The advantages possessed by this instrument are low prime cost and simplicity in use. A great drawback, however, is that a special experiment has to be conducted whenever it is desired to know the temperature of a furnace, involving time and labour; in which respect the water pyrometer is distincly inferior to other types which give a continuous indication which may be read off on a dial. The accuracy of the results depends to some extent on the observer, who may fail, for example, to allow the lump of metal time to attain the temperature of the furnace; or may delay the transit of the hot metal to the water. Taking all the possible errors into account, the closest approach to accuracy which may be expected under working conditions is represented by nearly 20° C. or 40° F., and hence the water pyrometer cannot be applied in cases where an error of this extent is of importance. It finds many useful applications, however, in processes which may be conducted successfully over a fairly wide range of temperature, and in which an occasional determination of the state of the furnace suffices.

Fusion Pyrometers.

A simple method for obtaining casual readings of the temperature of a furnace is to insert a number of substances of progressive melting

points, and to observe which have been melted and which have survived. For example, a series of salts, such as the following, may be taken, and a small portion of each placed on a plate and inserted in the furnace :—

Salt.	Melting Point. Deg. C.	Deg. F.
1 molecule common salt + 1 molecule potassium chloride	650	1202
Common salt	800	1472
Anhydrous sodium carbonate ...	850	1562
,, ,, sulphate ...	900	1652
Sodium plumbate	1000	1832
Anhydrous potassium sulphate	1070	1958
,, magnesium sulphate	1150	2102

On withdrawal from the furnace, inspection of the plate will show which of the salts has fused, and the temperature may then be approximately determined. If, for example, the first

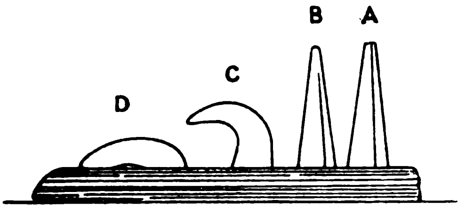

FIG. 3.—SEGER "CONES."

five in the above list were found to have melted, whilst the last two were intact, the temperature would lie between 1,000° and 1,070° C. The precision of the method evidently depends upon the interval between the melting points of the substances used, and recently Brearley has prepared a special series of salts which enable definite temperatures to be approximated closely by this means. These salts are made up into the form of small cylinders, each being labelled with its proper melting point, and are sold under the name of "Sentinel" pyrometers. A specially-prepared series of alloys is sometimes employed instead of salts; but the most accurate development of the fusion method is due to Seger, of Berlin, who produced clays of varying composition with melting points ranging from 590° C., or 1,094° F., to 1,890° C., or 3,434° F., no interval being greater than 30° C. For convenience in observation, these clays are shaped into triangular pyramids, as shown at A, Fig. 3. Several pyramids, possessing melting points judged to approximate to the temperature of the furnace, are inserted, with the result shown in the figure, where D is seen to have collapsed, C has bent over, B has become rounded at the summit, whilst A is intact. The temperature of the furnace corresponds to the melting point of C, and is read from a table which records the melting points of the pyramids with reference to the number stamped on each.

In order to furnish the same figure as would be obtained by other methods, the melting points of the materials used must be correctly known in terms of the gas scale. The method is simple and cheap, but suffers from the disadvantages that only intermittent readings can be taken, and that slight variations in the compositions seriously affect the melting points.

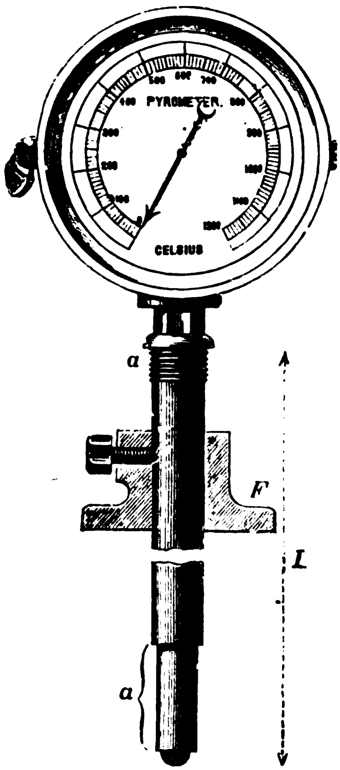

FIG. 4.

MISCELLANEOUS APPLIANCES.

Approximate measurements of high temperatures may be obtained by measuring the expansion of an iron bar encased in a fireclay tube, or of graphite in an iron tube, of which Fig. 4 is an example; or by enclosing mercury in a steel tube to which a pressure-gauge is connected, pressures being translated into corresponding temperatures by comparison with an accurate pyrometer. Both these methods are in use, but are not of sufficient importance to call for detailed description in the present lectures. Pyrometers based on the rise in temperature of

water or air, when forced through a tube placed in the furnace, have occasionally been used, and may possess a fair degree of accuracy; but are usually complicated compared with the generally recognised methods. The same remarks apply to instruments depending upon the altered viscosity of gases, or upon the change in refractive index. With this passing mention, we shall proceed to descriptions of the pyrometers which have been successfully employed for work of precision in various industries.

[The following instruments were exhibited:—

1. A calorimetric or water pyrometer, by Messrs. Siemens Bros. and Co., Ltd.

2. A plumbago expansion pyrometer, by Messrs. A. Gallenkamp and Co., Ltd.

3. A mercury-pressure pyrometer, by Messrs. A. Gallenkamp and Co., Ltd.]

THE CHRISTMAS TREE.

By Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.

> The Tree of Life,
> The middle tree, and highest there that grew.
> —Milton, *Paradise Lost*, iv. 194, 195.

Part I.

Only during the past fifty to sixty years has the fashion become prevalent in England of setting up "The Christmas Tree"* as a Yuletide decoration, and a most delightful vehicle for showering down gifts upon the young, in connection with domestic and public popular celebrations of the joyous Christian Festival of the Nativity. It is said to have been introduced among us from Germany,† where it is regarded as indigenous; and is probably a survival of some observance connected with the pagan Saturnalia of the Winter Solstice, in supersession whereof the Church, about the fifth century of our era, instituted Christmas Day. It has, indeed, been explained as being derived from the ancient Egyptian usage of decking houses at the time of the Winter Solstice with branches of the date palm, as the symbol of life triumphant over death, and therefore of perennial life in the renewal of each successive bounteous year; and the supporters of this suggestion point to the fact that pyramids of green paper, covered all over with wreaths and festoons of flowers, and with strings of sweetmeats, and other presents for children, are often substituted in Germany for "the Christmas Tree." But similar pyramids, together with similar trees—the latter usually altogether artificial, and often constructed of the costliest materials, even of gems and gold--are carried about at the marriage of Hindus in India, and at other of their religious processions, such as the Hoolee [Holi] or annual procession of the Vernal Equinox. These pyramids represent Mount Meru, and the Earth, and the trees, the Kalpadruma, or "Tree of Ages," and the fragrant Parajita, the "Tree of every Perfect Gift," growing on the slopes of Mount Meru; while in their enlarged sense they symbolise the constellated splendour of the outstretched spacious heavens, as of a tree deep-rooted in the earth, and laden with golden fruit. Both the pyramids and the trees are also phallic emblems of life, individual, and terrestrial, and celestial. Therefore, if a relationship exists between the Egyptian practice of hanging houses at the Winter Solstice with branches of the date palm, and the German, and now widespread English custom of using gift-bearing and brilliantly-illuminated evergreen trees (nearly always firs) as a Christmas decoration, it is most probably due to collateral rather than to direct descent; and this is indeed indicated by the fact of Egyptians having regarded the date palm as an emblem not only of immortality, but also of the starlit firmament on high.

The Hindus derive the origin of their race from Idavarsha, the "Enclosure," or "Garden of Ida," the wife of Manu,* and the Mother of mankind. Here they place their Olympus, the fabulous Mount Meru, the centre and culminating point of the earth, and the support and pivot of the heavens. Its slopes collect the celestial Ganges, that is, the dews and rains of heaven, and run them off into the lake Manasasarovara, "the most excellent lake of the Spirit." The terrestrial Ganges, having its reputed source in this lake, as it circles seven times round Mount Meru, forms the four lesser lakes wherefrom the four rivers of Idavarsha flow out into the four quarters of the world; and it is about the fountains of these four rivers that the Hindus place the sacred Kalpadruma and Parajita trees already named. Mount Meru, regarded geographically, may be localised in the Himalayan regions about the Pamir steppe; but it is

* Cassel, P. "Weihnachten, Ursprunge, Brauche u. Aberglauben," Berlin, 1862. 8vo.

† It is said in Cassell's "Household Guide," vol. i. p. 151, to have been first introduced into England in the household of George IV. by a German servant of Queen Caroline's. Reference is also made in this work to a tree of gold, set before Henry VIII. during some Christmas pageants at Richmond.

* The "Thinker," *i.e.*, Man.

quite impossible to identify the Kalpadruma and Parajita trees with any known botanical species; and they are merely mythical "Trees of Life," the idea of them being inspired by the primitive worship of trees as phallic divinities.

The traditions of the ancient Persians* place the scene of the creation of man in the Aryana-Vaego. In the first Fargard of the Vendidad, it is the first-named of the sixteen good lands, said to have been created by Ormazd (Ahuramazda), and afterwards cursed by Ahriman (Angra Mainyu). In the second Fargard it is described as the country of the first man, "the fair Yima." Under his golden rule 300 winters passed away therein; when, being warned that it had become over full of the blazing fires of human homes, and of herds and flocks, he, with the assistance of "the Genius of the Earth," extended its size to one-third more than it was at the first. Thus another 300 years passed away; whenafter he again enlarged it another third; and this process was again repeated, so that the Aryana-Vaego became double its original size. Then Ormazd called all the celestial gods together, and "the fair Yima" with them, and warned them that there were about to fall on the earth "the final winters" of fierce, foul frosts, with "snow fourteen fingers deep," before which all their flocks and herds would perish, alike those grazing over the open plains, and those that fed in the deep bosoms of the leafy dales, and those that were sheltered within the stables of their homesteads. Therefore, Yima was directed to make a four-square *vara*, or "Enclosure," two miles long on each side, and to bring into it "the seeds of men and women," "the bravest and best, and fairest on the earth," and "the seeds of fire," and of sheep and oxen and dogs; and to settle them by the green banks of the fountains of living waters that sprang up within the *vara*, and to establish therein this renewed dwelling-place of men. All this the fair Yima did; and then he sealed up the *vara* with a golden signet ring, and made a door to it, and a window, "self-shining within." None that was deformed, or diseased, or a lunatic, or that was imbecile, or impotent, or a liar, or that bore any of "the brands of Ahriman," might enter into it. But the men and women admitted within the *vara*, lived the happiest life there, and they never died, but dwelt there for ever in the presence of the Eternal Glory. In the Zend-Avesta references are also made to the Hara-Berezaiti, "the Heavenly Mountain" of Aryana-Vaego, whereupon the crystalline expanse of the heaven rests, and wherenigh the sun rises; and to the bridge Kinvad, "the Straight" [Sirat], "The brig o' Dread, na brader than a thread," stretching from the Hara-Berezaiti over Hell to Heaven; and to the "Tree of Healing and Immortality," "the White Homa Tree," called also Gaokerena, that grows by the head-springs of the Ardvisura fountain; and to the two rivers, the Arvand and the Daitya, flowing from this source, and replenishing all the rivers and seas of the earth. According to the latter Pehlvi texts, on the White Homa Tree sits the Säena bird [*cf.* Simurg] and shakes down from it the seeds of life in man, and beasts and birds and fishes and plants, that, as they fall, are at once seen by the bird Kamros, as it watches for them from the top of the Hara-Berezaiti mountain, and are carried off by it, and scattered far and wide over the world. The tree is protected by ten fishlike monsters, having their dwelling in the Ardvisura lake.

In these details we have the same mixture of mythical and actual geography as in the Puranic descriptions of the Idavarsha. Thus the Aryana-Vaego, although it refers to the original starting-place of the Iranian Aryas in Central Asia, is also an ideal country, in some of its aspects an earthly Paradise, and in others an Elysium, ruled over by Yima; who, as the first of men to die, is also the personification of death. Among the Persians he always remained, even as Death, the first bright consummate flower of humanity gathered by the grave, the gentle King of the sinless dead; but in Hindu mythology he becomes deformed into the terrible Yama, the god of Judgment and Hell. The Aryana-Vaego, therefore, is at once the original seat of the Iranian Aryas in High Asia, the Elysium of their departed ancestors, and the legendary Eden of the Aryan, and, indeed, of all the Caucasian races. The White Homa tree has always been botanically identified with the *Sarcostemma viminale*, or Soma plant; and I have always also included under it both the vine and the date palm*; but in its highest significance it is, like the Kalpadruma and Parajita trees, the poetical symbol of cosmical life. The original Hara-Berezaiti, and the Arvand and Daitya rivers, must be identified with the Hindoo Koosh or Parapanisus range, and some of the streams flowing from it; but their names, like

* "Sacred Books of the East," edited by Professor Max Muller, vol. iv.; "The Zend-Avesta," part i.; "The Vendidad," translated by Professor James Darmestetter, Oxford, 1880.

* See my Appendix on the Homa Plant, to Max Muller's "Biography of Words."

that of Mount Olympus, reappear again and again, variously modified, in the course of Aryan migration westward; that of the Arvand river being found as an appellation of the Elwand mountain, the Mount Orontes of classical geography, in Media, and of the River Orontes in Syria. The Hara-Berezaiti mountain, both in this primitive form of its name and the later form of Alborj, has undergone still more frequent displacements from east to west; its name having been successively attached to the Elburz mountains east of the Caspian Sea, to the Elburz mountains south of the Caspian, and to the Elburz mountains of the Caucasus. In the Assyrian inscriptions it is attached, in the slightly altered form of Allabria, to the Gordyæan, or Kurdish mountains, and it is on the latter, under the name of Lubar, that St. Epiphanius places "Noah's Ark." The name of Baris, assigned by Nicholas Damascenus to Mount Masis [Aghridagh] in Armenia, usually identified by Christian writers with the *hara-Ararat* ["the mountain of Ararat"] of Genesis viii. 4, whereon, according to the Bible, Noak's Ark rested after the Deluge, is supposed to be a direct corruption of Berezaiti. This primitive Iranian name certainly appears almost unaltered in that of Mount Berecynthus in Phrygia, the abode of the Great Earth-Mother, Rhea-Cybele. And wherever it travelled and became fixed, there, we may be sure, was carried and planted the ever-green legend of "the Tree of Life."

The legends of the Norse people, or Aryas of Northern Europe, also point to the colossal circle of the Caucasian range, stretching from the confines of China to the shores of the Black Sea, and beyond them, until it ends at Cape Finisterre in Spain, and the Atlas Mountains of Morocco, as the earliest cradle* of the human race; for Börr, who in their primitive mythology is the common progenitor of gods and men, is but a personification of these mountains. As-gard, that is "God's-ward," while mythologically the starry firmament ["flammantia mœnia mundi," "The Citadel of Chronos"], is geographically and historically Azov, "The Ward of the Asir." The Norse Olympus rises from the centre of Mid-gard, "The Middle-ward," the residence of mankind, separated by the circumfluent ocean stream from Ut-gard, the "Outer-ward" of the Jotuns or "Giants." Below Mid-gard is the shadowy underground world of the dead, Niflheim. From the centre of Mid-gard, and the summit of As-gard, springs the "Ash-tree," Yggdrasil, with branches spreading out over the whole earth, and reaching above the highest heavens, and three great roots going down into the lowest Hell, where lies coiled round them the serpent Nidhögg, "The Gnawer," Death, who, like the serpent Anunta of the seventh Hell of the Hindus beneath Mount Meru, typifies not only death, but the subterranean volcanic forces whereby the destruction of the world itself is ever threatened. Here the Paradisaical Yggdrasil is transparently a symbol of the universal life and joy and glory of Nature.

The inhabitants of Mid-gard are said to have been created by Odin, and his brothers Wili and Wi, from two pieces of wood, one of ash and the other of elm; the first being changed into a man called Askär—*i.e.*, Ash, and the second into a woman called Embla, *i.e.*, Elm. It will be remembered that the Greeks derived "the third race of men," who may be identified with the Aryas of the Bronze Age of Europe,* "from the ash-tree" [ἐκ μελιᾶν, Hesiod, "Works and Days," 144]. They also made the Caucasus mountains "the midmost part of the earth," "the beginning and the end of all things" [Hesiod, "Theogony," 738], the seat of the punishment of Prometheus, the son of Iapetus or Japheth, the mythical leader of the Aryan immigration into Europe.† Mount Olympus in Thessaly was the abode of the gods of Greece, according to Homer, and until the later poets translated them to the sky; but wherever the Greeks went they carried with them the name of this mountain, localising it in Bithynia, Mysia, Lycia, Lesbos, Thessaly, Elis, Laconia, and Cyprus; thus also unconsciously associating the original habitat of their race with some alpine region at the initial point of the line of their exodus from the East.

The Semitic traditions ‡ differ from the Aryan in distinguishing between the birthplace of the human race, Gan-Eden, "the Garden of Eden," and the mountain whereupon Noah's Ark, containing the forefathers of the renewed human race, rested after "the Deluge." Every tree pleasant to be seen and useful for food grew therein, and

* That is, earliest within the memory of man: for we must distinguish between the several historical Edens and the ethnographical centre, or centres, of the evolution of the human species.

* "Their houses brass, of brass the warlike blade,
Iron was not yet known, in brass they trade."
—Hesiod, *Works and Days*, translated by Cooke.

† Of course, Prometheus is a Sun-god also, and, therefore, naturally associated with the Caucasus mountains, as the starting-point, viewed from the West, of the sun's daily course round the globe.

‡ "Les Origines de l'Histoire d'après la Bible," par F. Lenormant.

"the Tree of Life," and the "Tree of Knowledge of Good and Evil." It was watered by a river that, after flowing through Eden, was parted into four heads. There can be no question of Sir Henry Rawlinson's identification of the Eden of Genesis ii. with the Gin-Dunish of an inscription of Assurbanipal or Sardanapalus, *circa* B.C. 668–40; that is, with the country surrounding the city of Babylon, watered by the Pallacopas [Pishon], Shat-el-Nil [Gihon], Tigris [Hiddekel], and Euphrates [Perath].* This district was familiarly known to the Babylonians as Gan-Dunias, "the garden of (the god) Dunias"; and the city of Babylon itself was known also by the name of Dintira, or Tintira, "the Divine Tree"; as the counterpart of the cosmic "Tree of Life," so often represented guarded by a cherub on either side on Babylonian gems and the "Nineveh marbles." More recently Sir Henry Rawlinson has identified the special spot wherein the terrestrial site of "the Tree of Life" was originally localised with the town of Eridu, the oldest seat of the worship of the Akkadian earth-god Enki, the Assyro-Babylonian Hea.* Nevertheless it is evident that the Garden of Eden is also the same mythical Paradise as the Idavarsha of the Hindus, and the Aryana-Vaego of the Iranian Persians, and the Asgard of the Norse, but localised in Mesopotamia by the Semites (as long before them by the Hamitic race), after they had forgotten their primordial Caucasian home in High Asia, or preserved the memory of it only in the tradition of a fabulous garden watered by a heavenly fountain, the source of all earthly streams. Then, as the Semites overspread Anterior Asia, and their survey of the countries surrounding them was enlarged, their conception of Gan-Eden was extended, like that of the Hindus of Meru, over the whole habitable world known to them, as encircled by the Oxus-Indus or Pishon, and the Nile-Indus or Gihon, and traversed by the Tigris and Euphrates.

Assyriological science—of which, in succession to its illustrious founder, Sir Henry Rawlinson, Mr. Sayce, the brilliant Deputy-Professor of Philology at Oxford, has long been the active exponent—has demonstrated in the fullest detail that the Biblical myth of Eden was borrowed from the cuneiform, brick-inscribed, literature of the Akkads, or primitive Chaldæans, a Scythian or Turanian people allied to the modern Turks; who, if they were not the actual aborigines of Lower Mesopotamia, were the first to establish themselves in that country during the period of the universal preponderance of the Scythians in Anterior Asia, and to lay there the foundation of the characteristic Hamito-Semitic culture of the Assyrian and Babylonian Empires, to which the nascent religion and arts of Europe are more directly, and far more intimately indebted than even to the civilisation of ancient Egypt. The Hebrews were probably vaguely acquainted with the myth from the time when Abraham went forth from "Ur of the Chaldees," "to go into the land of Canaan," and after the Captivity they must have become thoroughly familiarised with it.

Monotheism is, indeed, conjectured to have originated among the earlier Semitic immigrants into Chaldæa, who settled in the city of Eridu, whence it is supposed to have been communicated to the Iranian Aryas of Persia in the east; and is known to have been carried westward

* It is deeply interesting to find that, just as the Hindus try to reproduce Mount Meru everywhere, and in almost everything, so the Jews would seem to have endeavoured to repeat the geography of the fabled Eden in the plan of the city of Jerusalem, regarded by them as the centre of the earth [Ezekiel v. 5]. The city was watered by four streams, one of which always continued to be called Gihon [1 Kings i. 33, 38], and they were reputed to issue, through underground channels, from the fountains of fresh water beneath the Temple, whereto the Jews attached the profoundest sanctity [Ezekiel xlvii. 1–12, Joel iii. 18, Zechariah xiii. 1 and xiv. 8]. This sacred spring was associated, like the mythical Ganges and Arvand and Daitya, with a mountain the Jews called Moriah, identified by Lenormant, following the generally hazardous guidance of Wilford, with Mount Meru. Milton includes an anonymous mountain in his description of the Garden of Eden, "Paradise Lost," iv. 223–235:—

"Southward through Eden went a river large,
Nor changed his course, but through the shaggy hill
Passed underneath engulfed; for God had thrown
That mountain, as His garden mound high raised,
Upon the rapid current, which through veins
Of porous earth with kindly thirst updrawn,
Rose a fresh fountain, and with many a rill
Watered the garden, thence united fell
Down the steep glade, and met the nether flood,
Which from his darksome passage now appears,
And now divided into four main streams,
Run diverse, wandering many a famous realm,
And country, whereof here needs no account."

On this passage Bishop Newton observes:—"The river that watered the Garden of Eden was, we think, the river formed by the junction of the Euphrates and Tigris, and this river was parted into four main streams or rivers: two above the garden—namely, Euphrates and Tigris, before they are joined—and two below the garden—namely, the Euphrates and Tigris, after they are united again." This is the very conclusion forced on us by modern topographical researches in Mesopotamia; and that Newton should have so exactly anticipated them shows the great value of holding on hard by tradition in the investigation of such obscure questions of the archaic history of mankind.

* The neighbourhood of Kurnah, at the confluence of the Tigris and Euphrates in the Shat-el-Arab, about 100 miles from the head of the Persian Gulf, has always been regarded by its present Arab inhabitants as the site of the terrestrial Paradise (Persian *fir-dauz*, "a garden," Sanscrit *para-desa*, "far country"—of fancy), a remarkable proof of the credibility of the ethnical legends, and historical traditions of the immutable East.

into Syria by the Jews, through the instrumentality of whose Sacred Scriptures it has become naturalised over all Christendom and throughout Islam. If, therefore, Eridu was the original seat in Mesopotamia of the monotheistic sect of primitive Semites, their descendants, including the Hebrews, might well, for that reason alone, have for ever associated the place with the primæval Paradise of the human race.

But long anterior to the advent of the Semites in Eridu, it would seem to have been the centre of worship of the Akkadian earth-god Enki [Earth], called Hea by the Assyrians and Babylonians, who was also the double personification of the prehistoric introduction of civilisation into Mesopotamia, and of the sun in his southern course through the Indian Ocean: just as Dionysos, "the Assyrian stranger," is the double personification of the westward course of the sun, and of Phœnician commerce and Chaldæa-Assyrian civilisation, through the Mediterranean Sea. He was the great "deus averruncus" of the Chaldæans, who alone possessed the dread secret of the incommunicable name of "the great gods" of the seven planetary spheres, the mere threat of the utterance of whose name compelled the submission of the whole impious array of the demoniacal spirits of the underground world. As "Lord of the World" his wife is Davkina, a female deification of the earth; as "Lord of the Abyss [*absu*]," and the "Lord of Saliors," his wife is the goddess Bahu, *i.e.*, Chaos [*bohu* of Genesis i.], while as "Lord of the Great Land," *i.e.*, Hades, the land of the dead, he is associated with the goddess Mylitta or Ishtar, under her chthonian title of Ninkegal. Like Dagon, the fish-god of the Philistines, he is represented as a merman; and also as sailing with all "the great gods," in a glorious ark of cedar wood, over the black water of the traditional Deluge, a myth, as I believe, of the south-west monsoon of the Indian Ocean.

His attributes are the Arrow Head, symbolising the invention of cuneiform writing, ascribed to him; the Serpent, symbolising his general civilising influence, worshipped in the garden at Eridu in connection with "the Tree of Life"; and the Disc of 50 fiery spokes, obviously derived from his character as a Sun-god; and recalling to mind the *chakra* of the Hindu gods, and "the Flaming Sword" of the Cherubim in the Biblical account of the Garden of Eden, "which turned every way, to keep the way of the Tree of Life."

On the Assyrian sculptures the sacred Tree of Life is associated also with the symbols of Asshur, who gave his name to, or took it from, Asshur, now Kilah Sherghat, the first capital of the Assyrians. He was originally no more than the eponymous progenitor of their race, the second son of Shem, but was afterwards identified by them with the supreme God Il [*cf. Allah*] of the Babylonians, and substituted for him as head of the official pantheon of Assyria. He is usually figured in the form either of the Winged Solar Disc ["the Sun of Righteousness with healing in his wings," Malachi iv. 2], or a Dove, the prolific white dove of Syria, a universally recognised symbol of the active or generative reproductive power of Nature; the Almighty being still believed throughout Anterior Asia to manifest Himself in the form of this bird.

Frequently the Sun Disc is represented as shining down upon, or the Dove as overshadowing, the *ashera* ["grove" of Old Testament, A.V.], or conventional representation of the Tree of Life; the Dove in this connection being supposed to typify Nana, Mylitta, or Ishtar, the common wife of all the Assyrian and Babylonian gods, rather than Sheruba, the shadowy special consort of Asshur. She was the only goddess known to the original Akkadians, their universal Earth-Mother, by whose divisional deification, and duodecimal distribution, the Assyrians and Babylonians, who were very uxorious in their notions, managed to provide a separate wife for each of their twelve greater gods.* But Nana always remained among the pagan Semites of Anterior Asia the highest and only really individualised personification of the passive, or receptive reproductive power of Nature, into whom all the other goddesses, formed by the merely nominal reduplication of herself, are at once resolvable. She is regent of "the brilliant star" Venus, and, as her proper self, of the month Ululu —August-September—of which the Akkadian sign was the Virgin. Friday also, the seventh day of the Akkadian week, was especially sacred to her, and to marriage, over the rites of which she [*cf.* Lucina of Romans and Ilithyia of Greeks] presided; wherefore the early Christians held this day of evil omen and accursed, a superstition still carefully observed among the seafaring populations of the Mediterranean, by whom, in archaic times, she was regarded as their "divinest patroness and midwife." As

* These "wives" are but poetical figures, images, "idols of the nation or tribe" of their worshippers, and simply signify the feminine force, or energy [or *sakti* as the Hindus term their goddesses] of the gods. Compare Ausonius, "De Deis":

"Tum Iovis et Consi germanus, Tartareus Dis.
Et soror et conjux fratris, regina deum, Vis."

the planet Venus appears sometimes as "the Morning Star," and sometimes as "the Evening Star," so Nana was correspondingly distinguished by the Assyrians as "Ishtar of Arbela," "the Goddess of War," and "Ishtar of Nineveh," "the Goddess of Love." In her chthonian aspects she is the Assyrian Allat ["goddess"], after whom Queen Dido is called Elissa [Eliza]. Indeed, the story of Dido, whose sister Anna became deified among the Romans under the name of Anna Perenna,* is supposed to be a myth of the introduction of the worship of Venus into Italy. She is also the Arabian Venus, called by Herodotus Alitta and Alilat, and by the modern Arabians *al* Lat, who, with the goddesses *al* Uzza† ["the Mighty One"], and Manat, "the three daughters of God," was worshipped in Arabia, before the time of Mahomet, under the various forms of graven images and phallic stones and trees; and it is not impossible that the *stambhas*, or inscribed "posts," presumptively of phallic origin, set up by the Buddhists in ancient India, and now represented by the *dipdans*, or "lustral" columns placed before Hindu temples, may have derived their more usual name of *lat*, "a pillar," from the Arabian goddess Alilat. The Muslims have always identified the phallic stone [*lingam*], destroyed by Mahmoud of Ghazni at Somnath, A.D. 1024, with the goddess Lat of Arabia. In the East, Nana or Ishtar is again the Phœnician Astarte, the Canaanitish Ashtoreth, so often named in the Old Testament in connection with the *asherah* [in plural *asherim*], or conventional image of the Tree of Life, and the Atargatis of the Phœnicians, whose worship was diffused by them all over Asia Minor; where the priestesses who served her in her double capacity of "Goddess of War" and "Queen of Love," were the martial courtesans known to the Greeks as the mythical Amazons. Their name is usually said to be compounded of α privative and μαζός "the breast," because according to the professed explanation of this absurd etymology, they deprived themselves of the right breast that it might not interfere with the use of the bow. But more probably it was derived from the endearing Aramaic title of *Um* or *Umu*, given generally to the consorts of the Assyro-Babylonian gods, and particularly to Nana, or Ishtar, who was worshipped under this very appellation, as Um-Uruk, "the [chthonian] Mother of Uruk," at Erech, the great necropolis of Chaldæa, and in its Aryan [Iranian] form of Ma-bog, "Mother of the Gods," at Hierapolis, or Bambyce, now Balbec, in Syria, and again of simply Ma, "the Mother," at Komana in Cappadocia, and Pessinus in Phrygia. Her Amazons may be compared with the Ambubaiæ, or Syrian dancing girls of the Roman circus, and with the Bayaderes or dancing girls of the sacred* Basvi, Bhavin, and Mahari castes in India, whose Amazonian character I pointed out in the "Handbook to the British-Indian Section of the Paris Universal Exhibition of 1878." About B.C. 500, Nana was introduced into the pantheon of the corrupted Zoroastrianism of Persia under the name of Thanata, Anæa, or Nanæa, the Anaitis of the Greeks; and the statue of her at Cnidos, by Praxiteles, was regarded by antiquity as the masterpiece of that sculptor. The eastward extension of her worship under the Achæmenian kings of Persia is indicated by such names of places as, for instance, of the Afghan town of Bebi-Nani, *i.e.*, of "Our Lady Venus." We have a yet more interesting proof of the ancient prevalence of her worship in the West, in the Greek comedy of Νάννιον, by Eubulus [*circa* B.C. 37], so-called after its heroine, a courtesan—that is, in the original meaning of the word, a priestess of Nana. Nana, or Ishtar, was, in fact, the ubiquitous "Asiatic Goddess," the great "Dea Syria," "Dea Phrygia," "Pessinuntia," "Berecynthia," "Mater Dindymene," "Idæa Mater," and "Bona Dea," of the Greeks and Romans, called also Ops, and Rhea and Cybele†:—

"Renown'd for fruite of famous progenie,
Whose greatnes by the greatnes of none other,
But by herselfe her equall match could see."

She is also historically identified with the Aphrodite of Paphos and of Cnidos, and the Artemis of Ephesus; while in certain of her aspects she would seem to resemble Athene. Her name of Rhea is said to be the Assyrian word *ri*, for her sacred number, 15. Cybele, I believe, means simply "the Great" goddess [*cf. al Kabir*, "the Great," the thirty-seventh of the ninety-nine Muslim names of God]. The mysterious Cabeiri associated with her rites are, in my opinion, "the great gods" of the

* Anna Purna [literally, "Full of food"] is one of the names of the Hindu Earth-Mother Parvati [literally, the "Mountaineer"], as the provider of food.

† Compare Uzziel ["The Mighty One of God"], the Arch-angel, next in rank, in Semitic angelology, to Raphael.

* Not of the secular Ramjani, Kanchani, and Naikan classes. *Cf.* the *kedesah*, or "consecrated" and *zonah* of the ancient Semites, and ἱερόδουλος, and πόρνη of the Greeks.

† "Mater cultrix Cybele" [Æneid. iii. 111]; "Alma Cybele" [x. 220].

"Alma parens Idæa Deûm, cui Dindyma cordi,
Turrigeræque urbes, bijugique ad fræna leones."
[Æneid. x. 252-3.]

seven planetary spheres reduced to little talismanic figures [*cf.* *ναννιόν* and *nanus*], similar to those of the Dii Majorum Gentium and Dii Selecti, seen in any Hindu temple, set round the great image of the god or goddess to whom the temple is more particularly dedicated.

The most ancient representations of her are of a naked woman with a child in her arms, and it may be conjectured that the sublime vision in the Book of Revelation [ch. xii.] of the Woman clothed with the Sun and Moon, and crowned with the Twelve Stars—"the twelve [phallic] towers" [*cf.* *στοιχεῖα*, "uprights," "first principles"] of the Zodiac of the Arabs—was inspired by this conception of Ishtar as the divine harlot Mother of Nature. By the Phœnicians she was represented as a robed goddess, with four wings, and a conical, or a turreted, hat on her head, and generally with a dove, either held in her hand or perched on her shoulder. Sometimes she would appear, as in Arabia, to have been symbolised simply by the acacia tree, or rude phallic stones; and, judging from my own observation in India, I have no doubt that such were the forms under which she, and Il, and Asshur, and the rest of the pagan Semitic pantheon, were first worshipped in Mesopotamia, and in which the conventional Tree of Life [*asherah*] of Chaldæo-Babylonian and Assyro-Phœnician religion and art originated.

(*To be continued.*)

HOME INDUSTRIES.

Frozen Meat and British Handling.—Mr. W. D. Lysnar, Mayor of Gisborne, New Zealand, and chairman of the Gisborne branch of the New Zealand Farmers' Union, has just published a report on the New Zealand frozen meat trade with this country, which indicates great dissatisfaction amongst shippers, and is of considerable interest to consumers in this country. According to Mr. Lysnar, the handling and disposal of the meat in London are very unsatisfactory. The meat is not handled either with despatch or in a way to protect it from as much injury as possible. The average damage to all New Zealand meat imported into London Mr. Lysnar puts at from 10 to 12 per cent., and in his opinion this damage arises in London. He says that the system of sorting the produce in the hold of the ship instead of in a goods shed is wrong; that the system of discharging the ship with hatches only partly covered from the weather is wrong; that the method of handling the meat in running it down shoots and landing into barges and trucks is unsatisfactory; that most of the barges that are used to convey the meat from the ship up the Thames, to the various delivering points, are in an unfit state for the purpose; and that the method of carting the meat from the barge or store on the river bank to the Smithfield Market and to the railway stations for general distribution is very unsatisfactory and expensive. Mr. Lysnar says the meat could be handled in a much more satisfactory way in Bristol, Liverpool, or Manchester, where provision is made to deal with the produce in a very expeditious and cheap way. If the produce was sent to Liverpool, Mr. Lysnar states that it could be delivered at Birmingham at 40*s.* per ton, as compared with 53*s.* 9*d.* per ton from London, and with less damage.

The Cycle Trade.—Many causes have combined to make 1910 a bad year for the cycle trade. The bad weather, more especially in the early part of the year, when the foundation of the year's trade is laid, the dearness of rubber and the consequent advance in the price of tyres, the decline of cycling in the largest centres owing to the motor traffic, the strikes and lock-out in the North of England which prevented the working-men, who are the chief buyers of the ordinary bicycle, from buying in large numbers; all these causes have tended to depression in the trade. Given good weather, the expectation is that 1911 will show great improvement, more especially in the motor-cycle trade. A trustworthy engine, fitted to a light-weight machine, is now an accomplished fact. Even this year the motor-cycle trade has been good, and one company is said to have sold its output for several months ahead. The cycle export trade in 1910 has shown better results than the home trade. In the eleven months ended November 30th the number of cycles shipped from the United Kingdom was 120,450, of the total value of £504,994, against 98,405 and £433,191 respectively in 1909, and 91,590 and £430,692 in 1905. The export trade in motor-cycles also showed substantial growth. In the eleven months ended November 30th the number sent abroad was 2,936, of a value of £108,655, as against 1,576, valued at £57,764 in the corresponding period of 1909. The cycle import figures are not less satisfactory, showing, as they do, decreases. Taking the same period, to the end of November, the number imported was 418, of the value of £2,944, as against 499, valued at £3,573, in the corresponding period of 1909. The import of motor-bicycles has been somewhat less satisfactory, being 1,340, of the value of £42,756, as against 1,353, valued at £38,250, in 1909. The hire-purchase system seems to have gone out of favour, but it is still extensive.

Motor-Engines for Warships.—It is rumoured again that three large motor-engines are being built for a British "Dreadnought" of this and next year's programme, but confirmation is wanting. All that is certain is that the Admiralty have been enquiring of British makers of internal combustion-engines whether they would undertake the construction of engines much larger than any they have yet put upon the market.

Railway Companies and Plant.—For many years there has been sharp controversy as to the wisdom of railway companies building their own locomotives. It has been urged with much force that they would be better advised to go outside. A railway, it is argued, must work under serious disadvantages. When its demand is small, much of its plant must be idle, since it cannot take orders from outside to keep it occupied; when its requirements increase it may find its resources inadequate, and have to ask outside makers to help them—assistance which, in the circumstances, must be costly. Then a railway, secure from competition, has no incentive to conduct its works on strictly commercial lines, and the transference of orders to large independent companies would tend to do away with the heterogeneity of detail which is so noticeable in the engines of different companies. But the interests which favour the present system are powerful, and not easily overcome. It may, however, be that the tests which several of the leading railway companies have lately united to carry out with each other's engines may be the forerunner of the abandonment of the present system, and lead either to the establishment of joint works for the construction of locomotives, or the employment of outside companies. In the latter case, the railway companies would shut down their works for building purposes and concentrate the energies of these establishments on repair and research work. The alternative policy would be for the railway companies to establish, under railway ownership, large works in which all locomotives for the companies interested would be built to standard design. The probable result in either case would be substantial economies in the locomotive departments of the companies concerned.

Wool Supplies.—The consumption of wool during the present year has beaten the record, and it is unlikely that 1911 will exceed it. At the end of October the exports from Australia showed an increase, as compared with those of the first four months of 1909, of 72,000 bales. In November 1909 the shipments from the Commonwealth reached the immense total of 382,000 bales, but for the same month of the present year they amounted to 421,000 bales. Up to the end of November, or for the first five months of the present wool year, the exports of wool from Australia show an increase of 116,000 bales. The New Zealand exports, which showed a decrease at the end of October of 4,000 bales, at the end of November were 17,000 bales in excess of the exports for the corresponding five months of 1909. As was to be expected, the market for merino tops at Bradford is gradually declining, in consequence of these heavy shipments.

The Cotton Crop.—Notwithstanding more sanguine estimates and the ginning reports, Messrs. Neill Brothers hold to their estimate of 11,600,000 bales. They account for the heavy receipts by the desire of planters to sell at high prices and the strong trade demand. They assume, too, that 90 per cent. of the crop was ginned up to December 1st, against 88 per cent. last year. As to the Bureau Estimate, Messrs. Neill interpret the 11,426,000 bales as 11,314,000, because the Government's calculation weight is too small, and then, adding linters, they bring the total to 11,614,000 bales, which differs only very slightly from their own estimate. Meantime the International Association of Tropical Agriculture has published an address on cotton cultivation delivered by Professor Dunstan to the congress held at Brussels in May. It is a little belated, but it may be noted that in his opinion, if the best results in the production and improvement of cotton are to be got, Government departments are necessary. Professor Dunstan quotes the opinion given in a report issued by the United States Department that only a third of the available area within the cotton belt of the United States is cultivated, and great increases in the production on the present acreage may be expected from intensive cultivation. There are now being conducted, in twenty parts of the world, more or less scientific attempts to increase the cotton supply, but it must be many years before they have much effect on the large questions of supply and demand. It seems probable that cotton prices will continue to be high for some time to come.

Shipbuilding and the National Shipbuilders' Agreement.—The standing committee of the associated trade unions has been in conference with the executive of the Employers' Federation, with the Boilermakers' Society, and with the Board of Trade, with the result that assurances have been given that the observation of the national agreement shall be mutual. And so, after many weeks of enforced idleness, which have exhausted the funds of the Society, caused the men much misery, and the masters great loss, the dispute is settled, and an undertaking which ought to have been given when the York agreement was formulated has restored the shipyards concerned to their normal condition. During the stoppage of work the demand for new ships has increased, and next year promises to be a good one for the shipbuilding industry, always assuming that fresh labour troubles are avoided. And with the shipyards busy again, every branch of the iron trade will be more active. The production of steel was reduced during the lock-out by from 40 to 50 per cent. in the majority of the works, but the loss should now be quickly made up.

Murder and House Property.—It is curious how a murder of the sensational kind injures house property in the neighbourhood in which it was committed. The district in which Peace the Penge murderer lived suffered severely in this way, and now residents in Hilldrop-crescent, Islington, the place of the Crippen murder, have applied to the London County Council to have the name changed. Many of the houses are said to be now empty, and all the property has depreciated in value. The Council have asked the opinion of the Islington Borough Council, but their works committee say that they have no direct evidence as to

the views of the owners and occupiers of the houses in the Crescent, and without that they recommend that the name shall remain as it is. An instance of the name of a place being changed owing to its association with a murder is the case of the Euston-square mystery in the 'seventies. A petition resulted in the south side of Euston-square becoming Endsleigh-gardens.

CORRESPONDENCE.

YERBA (OR MATÉ) TEA.

Yerba Maté, the dried and pounded leaves and small twigs of *Ilex Paraguayensis*, has been mentioned once or twice recently in the Society's *Journal*, I notice. Jesuit tea is a most refreshing beverage, and I have very pleasant recollections of it some years ago in the Argentine. It was usually infused in a small gourd, and sipped through a silver bombilla while scalding hot. Each person present took a sip and passed it on. Personally, I always preferred to take it, when possible, as a tea without milk. In case you may wish to make a trial of it yourself, I am sending you a small packet of some I brought from Rosario in 1886.

If by chance you are aware of how it may be obtained in London I should be glad if you would let me know.

As Mr. John Ryle has pointed out, it contains very little tannin, and may be of use to dyspeptics, but my impression is that its greatest value might be as a heart stimulant, if taken periodically. After drinking it habitually several times a day over a lengthened period, one has some difficulty in doing without it, for, as I have said, it is a mild cardiac stimulant, and the effects of leaving it off suddenly may result in somewhat serious prostration, as I well know from personal experience. It is probably on account of its action on the heart that the natives only sip it instead of drinking it in quantities as I did. It has been stated that the mortality from heart diseases is greater in the Argentine than elsewhere, and the reason has been ascribed to maté drinking, whether rightly or wrongly I cannot say. CUTHBERT CHRISTY.

OBITUARY.

FREDERIC JOHN VAVASOUR GUY.—News has just been received of the accidental death by gunshot of Mr. Frederic John Vavasour Guy, of Kuala Lumpur, Federated Malay States. Mr. Guy served throughout the South African War with Van Allen's Field Hospital, and afterwards became manager of the Federal Dispensary, Kuala Lumpur, Selangor. In December, 1908, Mr. Guy joined a scientific expedition into the unexplored wilds of Perak. The expedition returned with a number of new botanical specimens, after undergoing great hardships. He was an enthusiastic hunter of big game; at his residence at Kuala Lumpur there is a fine collection of wild animals, birds, and reptiles —probably the finest in the Malay States. He joined the Royal Society of Arts in 1909.

NOTES ON BOOKS.

BRITISH WEIGHTS AND MEASURES. By Colonel Sir C. M. Watson, K.C.M.G., C.B. London: John Murray. 2*s*. 6*d*. net.

In 1906 Sir Charles Watson read a paper before the Society on the metric system, in which he set out the objections to its compulsory introduction into this country. The present book may be taken as a continuation of this paper, though in it the author does not express any opinion as to the merits or demerits of the proposed change. He contents himself by setting out in a popular and intelligible form the history of the origin of our present measures. He traces them all to the laws of the Anglo-Saxon kings, although, as he says, the investigation might be carried a long way further back until the origin of the measures and weights we are using to-day is to be found in the ancient measures of the East and of the Roman Empire. As a matter of fact, the principal denominations have been changed very little, or not at all, for the past thousand years, and it may reasonably be inferred that measures which have thus stood the test of time and practice are at all events fairly well suited for practical use. This is not to say that during this long period they have not developed in various directions, and consequently have become more complicated, though much of the complication has been removed by recent enactments, which have put an end to many of the various weights and measures used in different industries and for different purposes.

In practice most of the old gallons, pounds, ounces, and cubits have disappeared, and it is only here and there that the use of the ancient measures or weights has been continued. The multitudinous variations of the old denominations have often been enumerated, and their use or their existence employed as an argument in favour of the more uniform metric system. No doubt some still remain. One instance may be given, which is not mentioned by Sir Charles Watson. He names six different gallons, of which only one, the imperial gallon of 1824, is said still to survive. As a matter of fact the old barn gallon of sixteen pints is still in common use, at all events for the wholesale purchase of milk, and it may be assumed that there is a certain convenience in this, or it would not have been kept alive.

However, the relative advantages of the old British system with its complications, and of the new metric system with its admitted inconveniences, have often been discussed, and the discussion is still being waged as vigorously as ever. One conclusion at all events may be admitted, and that is that it seems very much easier to change the coinage of a people than it is to alter its weights and measures.

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FRIDAY, DECEMBER 30, 1910.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 4th, 5 p.m. (Juvenile Lecture.) ARTHUR MASON WORTHINGTON, C.B., M.A., F.R.S., Professor of Physics in the Royal Naval College, Devonport, "A Study of Splashes, conducted by the aid of Instantaneous Photography." (Lecture I.)

Most of the tickets have now been issued, but some still remain, which will be supplied to Members who apply for them at once.

Further particulars of the Society's meetings will be found at the end of this number.

EXAMINATIONS, 1911.

The Examinations will be held from April 3rd to 7th inclusive.

The last day for receiving applications will be February 28th.

The following are the subjects:—Book-keeping, Accounting and Banking, Shorthand, Type-writing, Economics, Précis-writing, Commercial Law, Commercial History and Geography, Arithmetic, Business Training, and Modern Languages.

The Examinations will be held at any place in the United Kingdom where an Examination Committee is willing to undertake the necessary arrangements. Applications for new centres should be submitted for approval at once.

The Examination Programme for 1911 containing the regulations for the formation of new centres, syllabuses of all subjects and the papers set in 1910 may be obtained from the Secretary of the Royal Society of Arts, John-street, Adelphi, London, W.C. (price 3d., post-free 4½d.).

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

INDUSTRIAL PYROMETRY.

By CHARLES R. DARLING, A.R.C.Sc.I., F.I.C.

Lecture II.—Delivered November 28th, 1910.

THERMO-ELECTRIC PYROMETERS.

It might be supposed, at first sight, that the electromotive force developed by a heated junction of two metals, increasing with the temperature, could readily be applied to the construction of a pyrometer. Yet it was not until more than sixty years after Seebeck discovered the phenomenon that a satisfactory instrument was introduced, for reasons which will now be considered. Firstly, it is essential that the metals used must possess melting points higher than the temperature to be measured; and hence, if it be desired to measure 1,200° C. or more, the only metals left to choose from are iron, nickel, palladium, metals of the platinum series, and the more recently-produced metals, tantalum and tungsten. Nor does it necessarily follow that any pair of these metals, taken at random, would give a satisfactory result, as instances occur in which the electromotive force generated first of all increases as the temperature rises up to a certain point, after which it diminishes, and, on raising the temperature still further, an electromotive force in the opposite direction is established. This occurrence is known as "thermo-electric inversion," and is shown by several pairs of metals. I take, as an illustration, a junction of iron and copper, and couple the free ends to the galvanometer. On heating in the burner, the spot of light moves to the right for a time, but, as the temperature of the junction rises, the spot is observed to return, and finally to pass the zero mark and travel to the left. If we attempt to obtain a clue to the temperature of the junction by observing the position of

the spot of light, we are confronted with the dilemma that each mark on the right of the scale will correspond to two temperatures, and the attempt would therefore be futile. Evidently, a suitable junction must not be liable to the inversion effect at any part of the range over which it is used, and the electromotive force produced must continuously increase as the temperature rises. This requisite still further restricts the range of selection; but beyond this it is necessary that the metals used must be capable of remaining at a high temperature for an indefinite period without undergoing oxidation or corrosion, or being liable to any change of internal structure that might produce an alteration in the thermo-electric value of the junction. It is no cause for wonder, therefore, that under such exacting conditions the production of a successful thermo-electric pyrometer was so long delayed.

The problem was finally solved by Le Chatelier, who introduced, in 1886, a pyrometer in which the junction was formed of platinum as one metal, and an alloy of 90 per cent. of platinum and 10 per cent. of rhodium as the other. This was used in conjunction with a d'Arsonval galvanometer, from the scale of which temperatures were read, and was found to be reliable and satisfactory. It would be difficult to estimate the benefits which have accrued from this epoch-making discovery, which at once enabled researches at high temperatures to be conducted with accuracy and ease, resulting in improved methods and economy in working. Shortly afterwards, Barus in America, and Roberts-Austen in this country, showed that the rhodium-platinum alloy might be replaced by an alloy of platinum and iridium, containing 10 per cent. of the latter metal, with equally successful results. The cost of these metals is an unfortunate drawback, but no cheap substitutes of a satisfactory character have yet been discovered.

Before proceeding to examine the practical forms of instruments in daily use, it will be of advantage to consider briefly the laws governing thermo-electric phenomena in relation to pyrometry. An ideal thermo-electric circuit consists of two junctions, A and B. One of the metals connects A to B, whilst the other metal is made in two pieces, the free ends of which are joined to the galvanometer. The law that governs this circuit is that the electromotive force generated is proportional to the difference in temperature between the two junctions A and B. We can demonstrate this law experimentally by the aid of a circuit, which I now couple up to the galvanometer. No deflection is shown, as there is no difference between the temperatures of the two junctions; but on placing a burner beneath one of them a current is immediately established in the circuit and the spot of light moves. But if now I transfer the flame to the other junction, we notice that the deflection falls off, and when the temperature of the second junction exceeds that of the first a deflection in the contrary direction is established. Finally, I place a burner beneath each junction, and when both attain an equal temperature no deflection of any kind is noted. This is owing to the arrangement of the circuit being such that the currents generated at each junction flow in opposite directions, and thus neutralise each other.

It would be a great advantage if this ideal arrangement could be carried out in practice, but the high price of platinum and similar metals acts as a serious deterrent to such procedure. If we imagine A to be the junction placed in the furnace, and B to be located outside in a cool place, the two junctions might suitably be joined together by the rhodium-platinum alloy. The free ends of the circuit would then consist of platinum wires, which would have to be carried to the galvanometer, which might be many yards distant, and ought, in an ideal arrangement, to possess platinised terminals. The high cost of such a procedure renders a compromise of some kind necessary, and the plan usually adopted is shown in the diagram. The junction to be placed in the furnace is made by fastening together two fairly stout wires, one of platinum, and the other of rhodium alloy, and is located at one end of a protecting sheath, and the wires are brought from the junction through twin-bore fireclay, which serves to insulate them, to brass terminals at the other end of the sheath. Copper wires lead from these terminals to the galvanometer, and hence at this end of the pyrometer there exist several junctions of dissimilar metals, viz., platinum and brass, rhodium-platinum and brass, and two junctions of copper to brass. But if all these junctions be kept at a constant temperature, identical with that existing when the pyrometer was standardised for temperatures, no error will arise; and in order to realise this condition in practice the cold end or head of the pyrometer is shielded by a covering made of some material which acts as a non-conductor of heat, such as wood or fibre, and the instrument

standardised at the temperature attained by the head when in use. These points of construction may be noted in the instruments on the lecture-table; in one, the head is contained in a wooden cover; in another fibre is used; whilst in a third (Fig. 5) errors due to alterations in the temperature of the junctions in the head of the pyrometer are prevented by passing a continuous stream of water through the containing chamber.

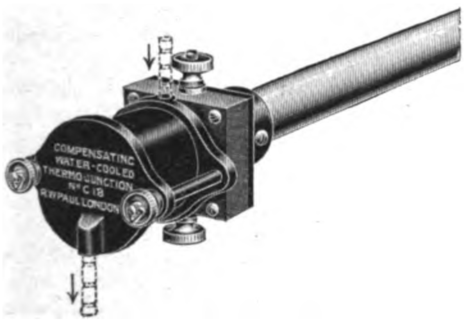

FIG. 5.—PYROMETER WITH WATER-COOLED HEAD.

It will thus be observed that the construction of a thermo-electric pyrometer is simple, and calls for no further mention except with regard to a few practical details. The "hot" junction is made by sealing the two wires together in a blowpipe fed with oxygen, and a spare quantity of each wire is usually contained in the head which may be drawn down the perforated fireclay tube to form a new junction when necessary. The protecting sheath, which prevents the wires from coming into contact with the gases or materials of the furnace, and thereby obviates corrosion, may be made of mild steel for temperatures up to 1,000° C. or 1,800° F. Beyond this temperature a better fire-resisting material, such as fused silica or fireclay, must be used, with the unavoidable disadvantages of fragility and slow transmission of heat from the furnace to the junction. The total length of the pyrometer is decided by the distance of the portion of the furnace at which a measurement is required from the exterior, remembering that the temperature recorded is that of the part surrounding the hot junction, and also that the head of the pyrometer should be kept at least one foot away from the exterior of the furnace.

The galvanometer first used by Le Chatelier was of the moving-coil pattern, with a mirror attached to the upper suspension strip, from which a spot of light may be reflected on to a scale. Most people who have been accustomed to work with mirror galvanometers would probably form the erroneous conclusion that these instruments could not be applied successfully in a factory owing to the vibrations caused by machinery or hammering. In the Royal Gun Factory at Woolwich, however—a department which has always been at the forefront in pyrometric work—mirror galvanometers are exclusively employed. These are of the Holden-

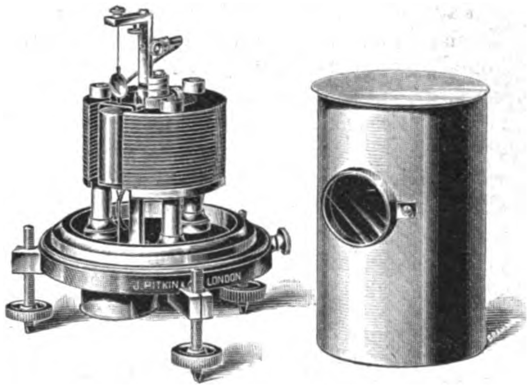

FIG. 6.—HOLDEN-D'ARSONVAL GALVANOMETER.

d'Arsonval pattern (Fig. 6), and are hung from a ring, which rests on three supports, by means of springs. One of these galvanometers I am using for experimental work in these lectures, and you will observe that we can shake it about and subject it to a considerable amount of rough usage without detriment. The advantage possessed by the mirror galvanometers over instruments provided with a pointer is that a longer scale, and therefore a more accurate reading, is possible. Most users, however, prefer an indicator in which a reading may be taken by noting the position of a pointer attached to the moving part of the galvanometer; and the progress made in the manufacture of electrical instruments has resulted in the production of many accurate indicators of this type. All these are millivoltmeters of the moving-coil type, which have the advantage of an evenly-divided scale. Amongst British makers may be mentioned the Cambridge Scientific Instrument Company, Messrs. Crompton and Co., Messrs. Siemens, Pitkin and Co., and R. W. Paul, all of whom are represented in the instruments on the table. The present practical limitations of these indicators do not permit of a greater movement of the end of the pointer than about six inches; which means that in a range of 1,200° a space of one inch represents 200°, and a closer reading

than 10° becomes difficult. With a mirror galvanometer, and a scale three feet distant from it, the spot of light may be made to traverse twenty-four inches or more, and thus to give a far more sensitive indication.

We shall now enter into the question of the marking of the scale of the indicator, so that standard temperatures may be read off directly. Let us suppose that the highest temperature to be read is 1,100° C., and that we start with a blank scale, and with the head of the pyrometer kept at the temperature it will attain in practice. We may now place the end of the pyrometer in boiling water, and when the reading is steady mark the position of the pointer 100° C. or 212° F. From the table of fixed points, to which reference was made in the first lecture, we can select several substances such as lead, antimony, common salt, and copper, and having melted the substance in a crucible, we insert the pyrometer and watch the pointer. As the molten mass cools, the pointer moves slowly towards its zero, but when solidification commences, this movement ceases, owing to latent heat being disengaged during the change of state, which balances the loss by radiation and prevents the temperature from falling until solidification is complete. I show this experimentally by dipping a thermal junction into melted wax in a glass tube, which I now immerse in water. You observe the deflection of the spot of light to decrease; then, whilst solidification is in progress, it remains steady, and finally falls again towards zero. The steady position of the pointer on the scale is marked with the number given as the melting point of the substance used; thus lead is 327° C. or 620° F.; antimony, 632° C. or 1,169° F.; common salt, 800° C. or 1,472° F.; and copper, covered with graphite, 1,082° C. or 1,980° F. We shall find, on a good indicator, that equal temperature intervals are practically equidistant on the scale, which may, therefore, be evenly divided up between the points, and the markings continued to the limit of 1,100° C. This is shown in the slide, which represents a calibration curve in which deflections are plotted against temperatures, and it will be seen that up to 1,100° C. the curve is nearly a straight line.

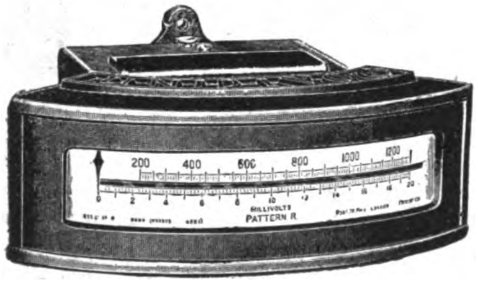

FIG. 7.
INDICATOR FOR THERMO-ELECTRIC PYROMETER.

An alternative method of marking the scale is to note the microvolts corresponding to the deflection, and to calculate the temperature from Le Chatelier's formula:—

$$\log E = A \log t + B$$

where E = electromotive force in microvolts; t = temperature; and A and B = constants depending on the materials used, and which must be determined beforehand. The former method is simpler in practice.

We may now enquire into the capabilities and industrial uses of a pyrometer made and calibrated in this manner. It is found that continued use at temperatures exceeding 1,200° C. or 2,200° F. causes an alteration in the thermoelectric properties of the hot junction, whereby the temperatures indicated are incorrect; but below this limit little alteration is noted. With a sufficiently large scale, and due attention to ensure that the head of the pyrometer is at the correct temperature, readings to within 5° C. or 9° F. may be obtained. As it is hardly possible to control a large furnace to a finer degree than this figure, the pyrometer fulfils all the conditions imposed by large-scale operations. The indications are automatic, and may be read with as little trouble as the time on a clock. It may therefore be used for all furnaces in which the temperature does not exceed 1,200° C., such as annealing furnaces for steel and other metals; in regulating temperatures for the hardening of steel; in retorts used for the manufacture of coal-gas; in lime-kilns; and in pottery kilns when the working temperature does not exceed 1,200° C. It is a common experience amongst manufacturers that owing to the absence of failures the initial cost of one of these pyrometers is saved in a few months; and we may therefore confidently look forward to a continued extension of their use.

Now it frequently happens that a knowledge of the rate at which the temperature of a furnace rises is quite as important as the actual reading, and it would be a manifest advantage if a continuous record of the temperature of the furnace over a given period could be secured. The first instrument for thus recording temperatures was designed by Colonel Holden, F.R.S., in conjunction with the late Sir W. Roberts-Austen, and was intended for use with a mirror

galvanometer. As made at the present time, it consists of a light-tight box, at one end of which the galvanometer is placed. Light from the exterior is reflected by a right-angled prism on to the mirror of the galvanometer, whence it is reflected on to a piece of sensitised paper wound round a cylinder which is made to rotate at a known speed by internal clockwork. If the mirror remain stationary—representing a steady temperature at the end of the pyrometer—a straight mark will be traced on the sensitised paper as it rotates, whilst fluctuations in temperature will cause the mirror to move to the right or left, thus producing a wavy line on the paper. By trials at known temperatures, the paper may be divided by lines representing say 10° C. between each pair, each line being marked according to the actual temperature it represents. The paper, after use, may be removed and fixed, and forms a permanent record of the operation which often proves valuable for future reference. Although this photographic process entails more labour than a recorder which, like others to be described subsequently, trace a line in ink, it possesses the superiority of delicacy of reading derived from the use of a mirror galvanometer.

The Siemens-Halske recorder is applied to a galvanometer which carries a pointer attached to the suspension. At the end of the pointer is attached a small stylus, and at stated intervals, regulated by clockwork, a bar descends and presses the stylus on to a sheet of paper, beneath which is placed an inked ribbon, thus forming a dot on the paper. The bar then rises, and remains free of the pointer for a sufficient time to allow the galvanometer coil to swing into the position which represents the temperature of the pyrometer, after which the bar again descends and makes a second dot. The paper is fed forward at a definite rate by clockwork, and is divided horizontally into temperatures. The record obtained is permanent, and consists of a nearly continuous curve formed by successive dots. The same principle is applied in the "Thread" recorder, made by the Cambridge Scientific Instrument Company, the action of which will be understood from the diagram, which shows the pointer attached to the galvanometer suspension and the bar which descends under the action of a cam. In this case, however, a V-shaped piece at the end of the pointer presses upon an inked thread, which is made to touch a graduated paper wound round a drum, rotated by internal clockwork. These instruments possess the advantage of giving a visible record. [Examples of the recorders described were exhibited in the room.]

There is one advantage possessed by thermo-electric pyrometers which I desire to mention before passing to the description of other types. Provided that the wires forming the junctions are identical in thermo-electric properties, any number of pyrometers can be attached, through a suitable switchboard, to a single indicator. This is shown in the slide, in which H^1 and H^2 are the hot junctions of two pyrometers. When the arm of the switch is moved to one position, the temperature of H^1 may be read; when on the second position, that of the hot junction H^2 is indicated, and so on indefinitely. The galvanometer may be located in the foreman's office, and he is thus enabled to ascertain the condition of all the furnaces under his charge without leaving the office. All the numerous furnaces in the Royal Gun Factory, Woolwich Arsenal, are thus controlled by means of a carefully-standardised indicator; and the economies effected in fuel, and in the prevention of failures in the hardening and other processes, amount to a sum representing many times over the cost of the pyrometric installation.

Fig. 8.—Cheap-metal Pyrometer with Cold Junction in Head.

Time will not permit of a description of the many ingenious details which in late years have been devised with a view to eliminating the possible errors which might arise in the practical working of these pyrometers. Even in a general survey of the subject, however, it is not possible to omit a reference to the results obtained with thermal junctions composed of the cheaper metals. For temperatures not exceeding 700° C. (1,290° F.), a junction of copper and constantan gives excellent results, and costs little to renew. Up to 900° C. (1,650° F.) copper and nickel or iron and nickel are satisfactory; the latter metals being employed in Crompton's pyrometer. The Foster Company now make an iron-constantan pyrometer to read to more than 1000° C., which costs little to renew if destroyed by continuous oxidation. When any of these junctions are

used, the head of the pyrometer may be abolished, and the wires led directly to the vicinity of the indicator, where a cold junction, not liable to fluctuations, may be formed as represented in our ideal circuit. Moreover, the electromotive force developed by these junctions, for a given rise in temperature, is five times as great as that yielded by a couple formed of platinum and rhodium-platinum; and this enables an indicator of the spring-controlled type to be used instead of a suspended-coil instrument. The former is stronger and cheaper, and the total cost of an outfit for reading temperatures up to 900° C. is in consequence comparatively trifling.

Instances in which processes have been improved, money saved, and failures averted by the use of thermo-electric pyrometers might be multiplied indefinitely. And thus the discovery of Seebeck, regarded at the time it was made merely as a scientific curiosity, has led to results of the highest importance in modern industry.

[The following instruments were exhibited :—

1. Pyrometers with ordinary and water-cooled heads by Messrs. Siemens Bros. and Co., Ltd., and R. W. Paul.

2. Indicators of various patterns by the Cambridge Scientific Instrument Company; Messrs. J. Pitkin and Co., R. W. Paul, Crompton and Co., Siemens and Co., and the Foster Instrument Company.

3. Cheap-metal pyrometers by Messrs. Crompton and Co., and the Foster Instrument Company.

4. Thermo-electric recorders by Messrs. Siemens and Co., the Cambridge Scientific Instrument Company, and J. Pitkin and Co.

5. A multi-junction pyrometer by Messrs. A. Gallenkamp and Co.]

THE CHRISTMAS TREE.

By Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.

Part II.

Among all races religion,* as the sense of Divinity in Nature, exhibits itself at first in those degraded forms of polytheism that are generically described by ethnologists under the term of animism, or the worship of the telluric powers of the upper [terrestrial] and lower [chthonian] earth; and it never rises above this low type of worship among races permanently arrested in their mental growth; although animism seems to possess in itself the power of indefinite development, being, indeed, the source of every known system of religion, whether polytheistical or monotheistical. Also within the proper limits of its arbitrary definition it assumes many shapes, such as fetichism, atavism, and phallicism. Fetichism is the worship by incantations, enchantments, and fairie (*fari*, to speak; *fatum*, the word spoken, fate), that is, by the intoning of magical formulæ, of any natural or artificial objects, under the conviction that the spirits imagined to inhabit them, or rather to be identified with them, can thereby be compelled to comply with the wishes of the worshipper. It is, strictly speaking, a system of sacramental conjuring, such as still flourishes among the Negroes, and the Mongols or Black Tartars, of North-Eastern Asia; and was the primitive religion of Chaldæa. Atavism is the worship of ancestors, as illustrated by the worship of patriarchs, founders, and heroes (Euhemerism) by the Greeks; of the domestic Lar by the Romans; of the *pitris* and *prajapatis* [Penates, Patriique dii] of the Hindus; of the *teraphim* by the Hebrews [Gen. xxxi. 19, 30, 32, 34, and elsewhere throughout the Old Testament]; and of *totems*, or representative family animals, by the Red Indians. At first atavism was, as it still remains among the Red Indians, a debased magical system of divination by means of visionary communion with the dead, or necromancy* specifically; but among the Aryas it gradually passed into a comparatively pure service rendered to graven and molten images, or idolatry proper; while among the Semites it became insensibly sublimed into the most uncompromising spiritual monotheism. The very name applied to the Diety by the Hebrews to distinguish Him, as the term *elohim*† [gods] could not, as the one true God,—a name they never, within their historical memory, applied to any false god, although during the period of their earlier kings they used it henotheistically,‡ and

* That is, religion in the sense of "relegens," fearing, reverencing, the gods; rather than of "religans," binding by creeds, rites, dogmas, customs, morals, etc.

* From the corrupt spelling of which word [compounded of *νεκρός*, a corpse, and *μαντεία*, prophetic power], as negromantia, we get, by translation, the phrase, "black art."

† Where in the English Authorised Version of the Bible the word God is used, the original Hebrew has *elohim*, "gods." This false translation, which is followed in the Revised Version, is excused on the pretence of *elohim* being the "plural of majesty"; an explanation utterly untenable, at least in all the earlier Biblical instances of the use of the word.

‡ A word, I believe, first used in Max Müller's "Hibber Lecture,' compounded of *ἑνός* (genitive of *εἷς*), one, and *Θεός*, God, and signifying the worship of one god for oneself,

not absolutely monotheistically, and, after the Captivity, held so sacred that they never pronounced it, always substituting for it, when reading their Sacred Scriptures, the word *Adonai*, "The Lord,"—this "separating name," this terrible name of "Jehovah," would now appear to have been transmitted to them from that of the family *teraph*, or *totem*, of the tribe of Joseph, and the house of Moses. In many of the armorial bearings and charges of noble European families we have, on the other hand, examples of the survival of *totems* as mere heraldic marks. Phallicism, which grew up inevitably from fetichism and atavism, and is in many of its aspects, identical with atavism, is the worship of the vital, active and passive procreative principles of Nature; under figures furnished by the rudest stones, by mountains and valleys, by trees, by serpents, by the sun, and by the poetical figment, common to all the Caucasian races, of the Tree of Life.

Among the Caucasian races, the low animist worship of the visible world was raised to the higher worship of Nature, in the two principal forms of (1) sabaism [from *saba*, "an host"—of heaven], or the worship of the seven planets, the twelve signs of the Zodiac, and the host of heaven generally, originating with the study of astronomy among the Hamites and Semites of Chaldæa, the special stronghold in ancient times, as China is in modern, of sabaism; and (2) polytheism, or the worship of personifications of the phenomena of Nature, that is, of "many gods." The latter worship is specifically idolatry, or the sacramental dramatisation of Nature, and it is the intuitive religion of the Aryan races. In the hymns of the Vedas, we see this polytheism passing from its simpler forms of direct worship of phenomena, to the deification of the very adjectives [on the principle of "nomen numen"] qualifying them. In the perfected polytheism of the Greeks, these deities, invested with all the thoughts, passions, and actions of human beings, are almost completely dissevered from the phenomena they impersonate, and by the virtue of the immortal beauty wherein they live and move, and have their being in the poetry of Homer, and in the sculpture of Phidias and Praxiteles, they will remain divine for evermore.

Monotheism, the final and most elevated expression of natural religious feeling, is the worship of a universally postulated Supreme Being:—

"Father of All! in every age,
In every clime, adored,
By saint, by savage, and by sage,
Jehovah, Jove, or Lord."

The minds of individual men of exceptional powers of generalisation must, indeed, from the beginning, have been lighted up, as by a supernatural illumination, with some glimmering of the unity of the godhead. Polytheism, with its hierarchies of "gods many and lords many," of itself suggests the idea of some one superior god, to whom the rest are subordinate; and, particularly, when characterised by the predominating worship of a Sun-god into whom, in every polytheistical system, all the other gods at last become resolved, after the manner of the resolution of every female deity into one all-absorbing Earth-Mother. We are thus enabled largely to explain the inextricable mixture of monotheistic doctrines with even the most rudimentary forms of polytheism; and, in fact, the majority of polytheistical divinities are found to be co-extensive in their mythology with the entire range of the religious conceptions of mankind, being at once mere fetich stocks and stones, and astral, and phenomenal impersonations, or idols, and more or less pure and beautiful symbols of the eternally self-existing First Cause of all things. From this point of view, indeed, polytheism might well be regarded as a practical application of monotheism, if not a degradation from it; and as justifying, in some measure, the orthodox theological dogma of an original revelation of monotheism to mankind in the generations of Seth [Genesis iv. 26]. But modern ethnography has almost conclusively demonstrated that the human race, regarded collectively, has in reality been led very gradually through animism, sabaism, and polytheism up to monotheism. Judaism does not afford any exception to this law of Nature, for it was only through the most painful experiences, and by very slow degrees, that the Hebrews arrived at the conception of the spiritual nature of the godhead, and as a nation they do not appear to have completely attained to it until after "the Captivity." The existence of atavism among them, in the patriarchal age of their history, has already been alluded to; and, with other forms of animism, it continued to subsist, and indeed prevail, in both Judah and Israel to the seventh and eighth centuries B.C. When Jacob took the stone on

without denying the validity of the god or gods worshipped by other nations. And it is clear that for a long time the Jews regarded *Jahveh* simply as the God of Israel, in contradistinction to Moloch the abomination of the Ammonites, and Ashtoreth, the goddess of the Sidonians, and Chemosh, the obscene dread of Moab.

which he slept on his way from Beersheba to Haran, and set it up on end for a pillar, and poured oil on the top of it, and called it Beth-el, "the house of God," he performed a distinct act of phallic worship, such as may still be witnessed every day, at every turn, in India; although in his case it may possibly have already been merging into the worship of the one true God. Seven hundred years later we find that Absalom, not having "a son to keep his name in remembrance," "reared up for himself a pillar which is in the King's dale" [*Shah-veh*], and called the pillar after his own name; just as to this day, in India, a wealthy Hindu, if certain of being sonless, will set up and endow a *lingam* named after himself, or his father, in perpetual witness of the family stock [*stirps*] and kin [*gens*]. Even Moses, the reputed author of the Decalogue, when the Israelites were plagued with fiery flying serpents in the wilderness, made a serpent of brass and put it upon a pole. It was a solar-phallic emblem, set upon a Priapian pole, a combination of symbols constantly occurring in the serpent-worship of India. Sometimes it is the image of the disc of the sun, featured after the face of man, that surmounts the supporting staff; and it was probably in such rude phallic posts and props [*cf.* ἕρμα, κίων, στοιχεῖον] that statuary everywhere originated. The "Serpent of Moses" was an object of worship at Jerusalem down to the eighth century B.C., when it was destroyed by King Hezekiah, who derided it under the nickname of Nehustan, that is "Brummagen." The Old Testament also bears witness to the enduring vitality of phallicism among the Hebrews in its frequent references to "high places," "groves" [*asherah*, pl. *asherim*, or conventional images of the Chaldæan Tree of Life], "oracles," and votive "pillars"; and, so late as the sixth century B.C., Ezekiel [xx. 28, 29] is found reproaching them for still presenting the provocation of their obscene offerings to "every high hill" and "all the thick trees." Notable trees are always associated with the phallic pillars* and hills mentioned in the Bible, just as in all other records. Thus, Joshua [xxiv. 26] set up the stone which was to bear witness to the covenant between Israel and God [literally, "the gods"], under the famous oak at Sichem [Genesis xxxv. 4], to be known thereafter as "the oak of the pillar" [Judges ix. 6], and "the oak grove of enchantments" [Judges ix. 37, where the English text of the Authorised Version has "plain of Meoneim," and the margin "the regarders of times" and seasons, *i.e.*, astrologers]. *Allah* is the Hebrew word in Joshua xxiv. 6, translated in the English Bible by "oak"; and it is the same word as occurs in Joshua xix. 26, and is left untranslated in the Authorised Version, as the name of a place, Alammelech, *i.e.*, "The Royal Oaks." In Genesis xxxv. 4, the Hebrew word translated "oak" is *elah*, and it is rendered by "oak" also in Judges vi. 11, 2 Samuel xviii. 14, 1 Kings xiii. 14, 1 Chron. x. 12, and Ezekiel vi. 13; and by "elm" in Hosea iv. 13; by "teil-tree" in Isaiah vi. 13; and by "plain" in Genesis xiii. 18. It is used also untranslated as a proper name: "Valley of Elah" in 1 Samuel xvii. 2 and 19, and xxi. 9. The word is everywhere supposed to mean the terebinth tree, and is so translated by the Septuagint. On the other hand, the Hebrew *allon* of Joshua xi. 16, translated by "plain," and of Genesis xxxv. 8, where it is translated by "oak," is like *allah* undoubtedly the oak; and as the *allon* of Joshua xi. 16 would appear to refer to the same tree as is indicated by the Hebrew *elah* in Genesis xxxv. 4, great uncertainty is felt as to whether the oak or the terebinth is meant by the Hebrew word *elah* as it occurs in the Old Testament.

But the interesting point, never, I believe, before remarked upon by any English writer, is that all these words, *allah*, *elah*, and *allon*, and the other Hebrew words, *el*, *ilon*, and *elan*, translated in the English Bible (A.V.) by the words "oak" "plain," and "trée," are all really one word, formed from the same root as the words *el*, *eloah* (Arabic *Allah*), "God," and *elohim*, "gods"; and it is just possible that, as used in the Bible, they are not meant, or were not originally, to distinguish the trees indicated by them botanically, but simply as holy objects, the groves of the autochthonous gods, and, indeed, the local gods themselves, of the places where they grew up, and which became remarkable by their presence, and the centres of the phallic worship the broad shadows of these trees attracted; and thenceforward, in every country, the centres also of its special religious and artistic culture. This is probably how Hellenic culture grew up round the oak groves of the dale of Dodona, and in the shelter of the pine-woods of Mount Olympus; and how the Scytho-Semitic civilisation of Chaldæa and Assyria and

* Compare collis, clumen, columen, and also the word columna as used by Martial, vi. 49. The Bible records no direct evidence of the worship of trees in Old Testament times, but indirectly affords overwhelming evidence of it, and its universality. See besides the passages noted in the text—Jeremiah ii. 20; iii. 6, 13; xvii. 2; Ezekiel vi. 13; xx. 28, etc.

Babylonia had its beginnings at Eridu, under the date trees that still wave in perennial verdure over the Tigris and Euphrates at the auspicious confluence of these "waters of Babylon" in the Shat-el-Arab.

These date trees are the antitypes of the Akkadian mystical Tree of Life; and of all Paradisaical trees alike of Hindus, Persians, and Norsemen. In the famous bi-lingual, brick-inscribed text, from the library of Assurbanipal [Sardanapalus, *circa* B.C. 668–40] at Kouyunjik, of the hymn on "The Seven Evil Spirits," the Akkadian and Assyrian words used to designate the Edenic tree of Eridu are translated [" Records of the Past," ix. 1437] "dark pine" by Professor Sayce:—

"[In] Eridu a dark pine grew, in a holy place it was planted,
Its [crown] was white crystal which towards the deep spread.
The [a lacuna] of Hea [was] its pasturage in Eridu, a canal full [of waters].
Its seat [was] the [central] place of this earth,
Its shrine [was] the couch of [*the primæval*] mother Zicum.
The [a lacuna] of its holy house like a forest spread its shade; there was none who within entered not.
It was the seat of the mighty, the mother [Zicum], beggetter of Anu.*
Within it [also was] Tammuz † [a lacuna] the universe [a lacuna]."

If the Akkadian and Assyrian names of the tree really mean "a dark pine," a very deep interest indeed attaches to them, as indicating that the Akkadians ["Mountaineers"] of Chaldæa still preserved among themselves the memory of a previous connection with some northern country to which coniferous trees were indigenous: for no species of them exists in the valley of the Tigris and Euphrates, where the date palm is, however, everywhere the most characteristic vegetable form. In Assyria, the oak, poplar, walnut, plane, and sumach are also found; but in Babylonia, if I may judge from the banks of the Shat-el-Arab, along which I botanised for more than a week in 1856, the only true native tree is the date palm; the occasional acacias, poplars, and tamarisks seen along with it being very dwarfed and scrubby. About Mohammerah and Bussorah, halfway between the head of Persian Gulf and the confluence of the Tigris and Euphrates,* the date palm attains the noblest proportions, and occurs in dense groves extending for miles along both sides of the river. The intermediate glades of grass are all over enamelled with buttercups and deep blue pimpernels, a combination of temperate with tropical vegetation perfectly enchanting to the eye, and that transported me with the feeling of the ground whereon I stood being still as fresh and bright as when first planted by God, with what were, according to the Semitic legend, trees and herbs of heaven before they became trees and herbs of earth; and indeed none other than "the Gate of Eden." In the enclosed gardens also were the fruits both of northern and southern climates, apples, and plums, together with pomegranates, oranges, and vines, the latter often trained up the stems of date palms, set in rows for the purpose. The vine does not ripen its clusters where the mean temperature of the year is higher than 84°, and the date will not flourish where it sinks below 84°, and it is remarkable that these conditions meet exactly in Palestine and Mesopotamia, the only two countries wherein the vine and the palm are found growing together in natural fruitfulness and luxuriance. When we turn to the monuments of Babylonia and Assyria, it becomes perfectly clear that the Tree of Life, so universally adored, and, as I have elsewhere elaborately demonstrated, so universally reproduced in decorative art from the remotest ages in the East, is nothing but the palm—

"Encinctured with a twine of leaves,"

representing at once the Soma plant and the vine. Originally it was worshipped by the Turanian Akkads at Eridu, as a phallic symbol, the palm representing the male principle in nature, and "the fruitful vine," when trained round it, the female. Afterwards, during the time of Hamitic predominance in Chaldæa, a higher astronomical, or rather astrological, significance was given to it; while, under the Semites, it became associated with Nana or

* The Akkadian "Sky-god," and called "The Father of the Gods."

† Or Duzzi, "The Sun of Life," the Biblical [Ezekiel viii. 14] Tammuz—

"Thammuz yearly wounded,"

and the Adonis of the Greeks, who is torn away from Ishtar in the flower of his adolescence, and recovered by her from the gloom of Hades; as told in the Akkadian songs from the *Idzubar Legend*, entitled "The Descent of Ishtar." These "amorous ditties" are an obvious myth of the sun in his southern declination over the Indian Ocean, similar to the Deluge myth.

* The junction of the two rivers is more like a portage than a confluence, for it may be said to extend from Swaije on the west—in a prolonged reach of over sixty miles, almost coincident with the thirty-first parallel of northern latitude—due east to Kurnah; and this reach is the river "that went out of Eden to water the garden." Eridu may be identified with the present village of Abu-Shahrein, about ten miles from the right bank of the Euphrates, south of Swaije.

Ishtar, the Ashtoreth of the Sidonians, and with Asshur, and, it may be presumed, also with the supreme deity of the Babylonians, Il [Hebrew *Eloah*; Arabic, *Allah*]; for Babil—"the Gate of God"—the Semitic name of Babylon, is said to be an idiomatic translation of its Akkadian name, Ka-Tintira, Ka-Dingira, or Ka-Dimira, "the Gate of the Divine Tree." Thus, even if it never really was a symbol of abstract deity, it was at once not only a phallic tree, but the mystic emblem of cosmical life, terrestrial and celestial, in man and beast and bird, and in trees and herbs, and in the sun and moon and five lesser planets, and the twelve constellations of the Zodiac, and all the hosts of the fixed stars, for ever shining beside the banks of the "Milky Way," the heavenly Euphrates [*cf.* Eridanus], after the similitude of the vine-clad palm of Hea, by the waters of Eridu. It is identical, historically, with "the Tree of Life," and "the Tree of Knowledge of Good and Evil," of the Hebrew myth of Eden; and it probably suggested "the Tree of Life," of St. John's vision [Revelation xxii. 2], "which bare twelve manner of fruits, and yielded her fruits every month, and the leaves of the tree were for the healing of the nations"; and which, whatever it may typify in the Apocalyptical sense, is a sublime poetical figure of the sun as "the giver of life," moving in his annual circuit through the twelve signs of the Zodiac. I believe also that the conventional Assyrian representations of "the Tree of Life" will be found to be directly connected with the Thyrsus of Bacchus, and the Maypole.

Canon Rawlinson, in "The Speaker's Commentary on the Bible" [vol. iii. 369], suggests the identification of Semele with a hypothetical female form of an obscure Assyrian god, Semel, whose name is said to occur several times in the Bible, in the original Hebrew, as in Deuteronomy iv. 16, where the English Authorised Version translates it "figure," and 2 Kings xxi. 7, and Ezekiel viii. 3 and 5, where it is translated "image," and 2 Chronicles xxxiii. 7, where it is rendered "idol." Again, Professor Sayce, writing in the *Athenæum* of September 26th, 1885, of her identification as the wife of Semel, as quite independently suggested by himself in the *Athenæum* of September 12th precedent, observes that she seems to have been the goddess of the grape, among some of the close neighbours* of the Assyrians, who was consumed by fierce heat of the sun in giving birth to the wine-god Dionysos. The etymological meaning of the word *semel* in Assyrian is really image, and Semel was probably a local rural deity, analogous to the classical Priapus, and worshipped with other divinities, into whom he would appear to have been rapidly absorbed, under the form of the *asherim*, or reduplicative images of "the Tree of Life" of Eridu.

It seems to me from the elaborations of the topography of Mount Meru by the Hindus, and of the Aryana-Vaego by the Iranian Persians, that they must have been in some degree directly suggested by the Chaldæan myth of Eden; but I do not think that there can be any direct connection between the latter and the Norse myth of Asgard. Still less is it probable that, even if the original Tree of Life of the Akkadians was "as dark pine," "the Christmas Tree" of the Germans and English was derived directly from it. The latter one would presume to be rather connected with the Yggdrasil tree of the Norse myth, and to have been substituted for the ash at Christmas by the converted Germans, because its evergreen foliage made it a more appropriate decoration at this season of the year. At the same time, Professor Sayce's translation of the Akkadian verses on the Tree of Life does suggest that the custom of using pine trees in connection with religious observances may have been introduced from the beginning by some Aryan or Turanian tribe, coming into Europe direct from the Alpine regions of Asia, where pines constituted the principal vegetation. It must not be overlooked, in this connection, that Gothic architecture* has been as much influenced by the pine form as classical architecture by the palm form; the Ionic column in particular, and all that is Ionic in Greek architecture, being directly taken from the central conventionalised palm shaft, and circumferential trellis of vine leaves, of the Assyrian *asherim*, or images of the "Tree of Life." The Turanian architecture of Buddhism, as represented more especially by the seven-roofed pagodas of Further India and China, seems also as if it might have been suggested by different species of pine trees, as seen in silhouette; although their sacramental construction in seven storeys betrays the direct inspiration received from Chaldæa, whence all the now world-wide ideas of the good and bad luck of certain numbers are derived; these ideas having originated in the astrological study by

* The original habitat of the vine is the slopes of the mountain ranges stretching from the Caspian Sea southward to the valley of the Tigris and Euphrates, and in the Persian portion of this region its vernacular name is *dims*.

* The German Christmas *Baum-Kuchen*, or "Tree-cakes," modelled after the fir-tree, might be well synonymed "Pagoda-cakes," so closely do they take the shape of Chinese pagods.

the priests of that country of the different numeral aspects of nature—such as day and night (2); heaven, earth, and the under-world (3); the four (4) quarters of the sky; the seven (7) planets; the twelve (12) signs of the Zodiac.*

For my own part, I was very early led to identify "the Christmas Tree" with "the Tree of Life," and chiefly from having been accustomed to entertain my native Indian friends, of all religions, on Christmas Day. I have always found them a good deal better Christians than myself; but, apart from that, I had to make my tree a symbol of universal charity and religious reconciliation, and of pan-Aryan brotherhood: and this is how I did it. I placed some green bush on a mound, resting on a coiled serpent or dragon. The mound was Mount Meru, Hara-Berezaiti, Olympus, Asgard, the anonymous Akkadian mountain of Paradise, Mount Moriah,—the world itself. At the top of the tree I fixed the symbol of the universal empire of Christianity, wherefrom flowed down all over the tree seven differently-coloured streamers symbolising the seven Christian virtues. Next in order came representations, in their proper colours, of the seven planets †:—Saturn, black; Jupiter, orange; Mars, red; the Sun, gold; Venus, "Neapolitan yellow"; Mercury, blue; and the Moon, silver. Outside these I arranged the circle of the Zodiac, the six signs representing obsolete southern winter, or monsoon suns, *viz.*, the Bull, the Crab, the Virgin, the Scorpion, the Goat, and the Fish, in frosted silver; and the six signs representing obsolete northern summer suns, *viz.*, the Ram, the Twins (*i.e.*, sun and moon), the Lion, the Scales, the Archer, and the Water-bearer, all in burnished gold. Then succeeded the Vedic Hindu gods, the Greek gods, and the Egyptian and Assyro-Babylonian gods, the tree itself representing the Turanian phallic symbols. The tree was also loaded with fragments of all the noblest products of the earth, and with gifts, and illuminated with 84 [$7 \times 12 = 84$] lights, representing the hosts of heaven in their 84* constellations. Returning again to earth, I there set a group illustrating the terrestrial scene of the Nativity; while, from under the mound supporting the tree, issued four silver-blue ribbons to the four corners, or four sides of the table, whichever corresponded with the four cardinal points, representing the four rivers of Paradise. Before it stood, not the Cherubim barring the way to the Tree, but the familiar image of Father Christmas, welcoming all to it. Beneath all was spread a sheet, patched, like "the ancient" of the P. and O. Company, of red, yellow, blue, and white, the Hindu coloration of, respectively, the East, South, West, and North [sometimes rendered in black], "imagined corners" of the Earth and Space; the Hindus, as Sun worshippers,† taking the four quarters of the compass in this circular, right hand order, and not in the cruciate order adopted throughout "Christendy."

It can be made of the simplest and cheapest materials, or the costliest, and in either is equally interesting: for, thus constructed, the Christmas Tree is no longer an accidental, almost chaotic decoration, but is instinct with meaning, understanded at a glance. It was a little shocking at first to the orthodox. But its charity is not strained. It is not only a tree of reconciliation, but an object-lesson

* The most mystical of these numbers were, and, in India, still are, 3 and 7. Ausonius [Griphus, Idyll. 11], running in 90 lines through the notable triplices of his date, begins :—

"Ter bibe, vel totiens ternos; sic mystica lex est,
Vel tria potanti, vel ter tria multiplicanti,"

and ends the list, line 88 :—

"Ter bibe; tris numera super omnia; tris Deus Unus."

† This is the order and colouring of the planets by the Chaldæans, who were the inventors of the days of the week. It has always puzzled people that, the Chaldæan order of the planets—which is the natural one, on the supposition that the earth is the centre of the solar system—being, as here given, the order of the days of the week should be so different. The explanation has been preserved in India. Not only each day of the week, but every hour of each day was, and in astrology still is, sacred to one of the above planets. Well, beginning with Saturday, the first day of the Chaldæan week, its first, eighth, fifteenth and twenty-second hours are each dedicated to Saturn, the twenty-third hour to Jupiter, the twenty-fourth to Mars, and the first hour of the following day to the sun, and, therefore, the second day of the week is Sunday. Proceeding in the same way, the third day is Monday, the fourth Tuesday, the fifth Wednesday, the sixth Thursday, and the seventh Friday. The Jews, to separate themselves from the surrounding Gentiles, made Sunday the first day of the week, keeping Saturday as their Sabbath, while the Christians, in commemoration of the resurrection of our Saviour, made their Sabbath on Sunday.

* In India, where everything in heaven has its duplicate on earth, the rural villages have been popularly arranged from the very earliest traditions of the people in groups of eighty-four [*chaurasi*], similar to our "hundreds," a very plain indication of a primitive connection between Chaldæa and India. See Edward Thomas in Marsden's *Numismata Orientalia*, new edition part i., "Ancient Indian Weights," p. 20 (Trübner).

† Most solemnising is the simple Hindu worship ["ad galli cantum," and "matutinus"] of sun-rise—as also of sun-set ["ad incensum lucernæ"], but I never saw a temple in Western India that appeared to be oriented intentionally. They all seemed to face East, South, West, and even the North indifferently. But when a temple happened to face the East, and being well open to the East, the suddenness, due to the short twilight of India, of the up-spring of the sun, and the impact of its beams on the shrine, flashing like shafts winged from the golden bow of the god, Surya, of "the thousand-rayed quiver," the effect was dramatically moving, and only passed off as with the rapidly spreading illumination of the whole heavens one's feelings and thoughts relapsed into their preoccupations under "the light of common day."

in mythology, and in the history of the evolution of religious ideas, learned at once, and then accepted ungrudgingly. The effect on my Indian friends was always electrical. They experienced an intellectual sympathy with Christianity they never knew before; and when at parting I presented them with a duly "teinded" Yule log, to carry away with them wherever they went the Promethean seed of fire, as the living symbol of pan-Aryan unity, I knew they had spent with me the very happiest day of their lives.

Primitive Christianity did not hesitate to accept not merely the symbolism, but even the teaching of the heathenism in the midst of which it gradually assumed its present ecclesiastical organisations. Those, of course, who regard the dogmatic creeds of Christendom as of divine revelation, in the narrower technical sense of the word, explain those obligations of ecclesiastical Christianity to paganism, more especially to that of ancient Chaldæa and Egypt, by the assumption of a primitive revelation, wherefrom mankind at once fell away, and whereto they had to be brought back by renewed special revelations. But those who see in "the faith once delivered to the saints" the results of historical evolution, or divine revelation in the proper sense of the phrase, will recognise in the cosmological fables and dark moral parables of the demonolatrous Akkadian "psalmists" the first half-articulated religious conceptions to which our technical theology has merely given the more definite and precise expression dictated at different dates by the circumstances determinative of the successive steps of the whole course of the civilisation of the Old World throughout the past four thousand years.

"As little children lisp, and tell of heaven,
So thoughts beyond their thought to those high
bards were given."

Christianity is essentially a chastening and redeeming influence, inherently as independent of forms and dogmas as it is reverently observant of all such as can be used for working out the spiritual salvation of the world; and before a fixed organisation was imposed on it, and extraneous events brought it into deadly conflict with imperial Rome, and infected it with a self-protective leaven of exclusiveness, it associated itself, with the large-hearted freedom, prompted by an intuitive sense of its Catholic truth, with whatsoever was intrinsically honest, just, pure, lovely, and of good report, or of any virtue and praise, not merely in the latent doctrines, but also in the open, palpable iconography of the surrounding heathen, giving to these beautiful "spoils of Satan," as Keble, unconsciously plagiarising the language of Akkadian dualism, terms them, their highest significance:—

"And these are ours: Thy partial grace
The tempting treasure lends:
These relics of a guilty race
Are forfeit to Thy friends:
What seem'd an idol hymn, now breathes of Thee,
Turn'd by Faith's ear to some celestial melody."

The select races of mankind would probably have risen, each independently, in the fullness of time, from the lowest to the highest forms of religion; but the advancement of the historical Caucasian races from fetichism, atavism, and phallicism, to sabaism and polytheism, and again, through the idolatrous worship of the sun, as "the Ancient of days," to monotheism, was actually due to the direct reciprocation of religious ideas between them in the course of that cosmopolitan commerce of antiquity of which the countries of the Mediterranean Sea and the Indian Ocean were the perennial fresh springs, and Egypt and Mesopotamia the head centres of exchange. The widespread comparison of religious ideas thus induced resulted everywhere in a large absorption of countless local deities into each other, and a further consolidation of a selection from them into colleges of governing gods under the presidency of one of their number, who was regarded as above the rest; and it was the worship of Bel, or Baal, the predominant national god, under varying forms and names, of the Semites of Anterior Asia, that immediately led to the gradually-perfected conception among all the Caucasian races, Aryan as well as Semitic, of one universally supreme God, to the express [literally "squeezed out"] exclusion of every other god. The commerce established between Chaldæa and the Indian Ocean and Mediterranean Sea about B.C. 2000, a date closely corresponding with that more precisely assigned by Rabbinical chronology to "the Call of Abraham" [B.C. 1921], and which became more and more intimate in the course of every century, from about B.C. 700 down to the dissolution of the Western Roman and the Persian Empires, more especially generated during the latter period those humanising conceptions of the parental relations of God with men to which the teaching of the Gospels of the New Testament gives the highest contemporary, and, if we may judge from its still unspent and unabated force, their final expression. This later trade, as organised by Psammetichus I., in Egypt, and by Nebuchadnezzar

the Great, in Babylonia, the far-reaching effects whereof were already realised by the writer of the Book of Daniel, as he witnessed its wide-spread operation in the second century B.C.,* successively accomplished its inevitable moral consequences in every country embraced by it, until about the Christian era there seemed the possibility, but for adverse circumstances that subsequently supervened, of the whole world of antiquity becoming of one cosmopolitan religion, based on a common faith in the Fatherhood of God. In India, Hinduism became internationalised as Buddhism, and Judaism as Christianity in Syria and Egypt, while in Europe classical paganism seemed also on the point of becoming transformed, through neo-Platonism, into the purest of all forms of Christianity. But then followed the overthrow of Rome and of Persia, catastrophes that gradually broke up, and in the end entirely destroyed, for three hundred years, the immemorial overland commerce between the East and the West. The East being thus, at the most critical period of its Hellenisation, cut off from the West, India rapidly relapsed into the strictest form of national and exclusive Hinduism; and the diffused humanitarian Judaism of Anterior Asia became differentiated, as Mohammedanism, from the specific type it had already assumed in the dogmatic Christianity of Europe, and permanently established itself wherever, in Asia and Africa, the vitalising Hellenic element was either deficient, as in Syria and Egypt and Persia, or altogether wanting, as in Arabia and Turkestan —inaccessible regions that to the last will remain the most formidable refuges of Islam.

European Christianity, unfortunately, through the accident of the impatience of some of its early converts of the military discipline of Rome, was at its beginning placed in opposition to the general philosophical, literary, artistic, and scientific culture of the Gentile world, and thenceforward in more or less marked antagonism also to the modern secular life of the West.

Happily, in India there is no gulf fixed in the popular belief between heaven and earth; and the Brahminical religious life has never sundered itself from the daily working life of the laity, but is a component part of it, and indissolubly bound up with it; and we may, therefore, hope that in India, under the *Pax Britannica*, Christianity, whether taught by missionaries of the churches, or, more consistently with itself, through the administration of equal laws, and the public and private example of our righteous dealing, will have the exceptional opportunity of drawing an ancient people into its fold, by its unstrained spiritual influences, illumining in them what is dark, raising what is low, and supporting and confirming all their higher ideals of duty and amenity, and without desecration or defamation of their traditional beliefs and worship, or the substitution of a foreign social system and ecclesiastical organisation for their own indigenous and sacrosanct family, municipal and national institutions; indeed, without involving any breach in the continuity of their civilisation, or any dislocation of the relations between their priesthood and themselves, such as has for a thousand years overshadowed and embittered, where it has not altogether blighted, —as in Spain, and perverted,—as in France, the progress of the West.

Thus India, the inviolable sanctuary of archaic Aryan civilisation, may yet be destined to prepare the way for the reconciliation of Christianity with the world, and through the practical identification of the spiritual with the temporal life, to hasten the period of that third step forward in the moral development of humanity, when there will be no divisions of race or creed, or class, or nationality, between men, by whatsoever name they may be called, for they will all be one in the acknowledgment of their common Brotherhood, with the same reality, and sense of consequent responsibility, with which, two thousand years ago, they recognised the Fatherhood of God, and two thousand years again before that an exceptionally endowed tribe of Semites, in the very heart of Anterior Asia, formulated for all men, and for all time, the inspiring and elevating doctrine of His Unity.

* Antiochus Epiphanes, against whom the Book of Daniel is directed under guise of an attack on Nebuchadnezzar, reigned B.C. 175-164, and the trade of which its author was the eyewitness is, as prophetically seen in its spiritual results, "the fifth kingdom" of Nebuchadnezzar's dream [ch. ii.], and the "kingdom of the saints" of Daniel's own dream [ch. iii.]; by the saints being meant the highly idealised Jewish supercargoes, brokers, and commission agents, and capitalists, into whose hands the inspired pamphleteer saw the whole contemporary commerce of Babylon daily passing.

MINERALS OF THE UNITED KINGDOM.

According to the General Report on Mines and Quarries for 1909 (Cd. 5413, Part III.), the total value of all minerals raised in the United Kingdom during the year amounted to £119,394,486, a decrease of £10,609,184, as compared with 1908. This decrease is mainly accounted for by the decreased value of coal.

The total output of coal was 263,774,312 tons,

and the value, £106,274,900, showing an increase of 2,245,517 tons and a decrease of £10,323,948 respectively on the figures for 1908. The average price of coal was 8*s.* 0·7*d.* per ton in 1909 as compared with 8*s.* 11*d.* in 1908.

The quantity of coal exported, exclusive of coke and manufactured fuel, and of coal shipped for the use of steamers engaged in foreign trade, was 63,076,799 tons, an increase of more than half a million tons on the exports for 1908. France received over 10⅞ million tons, Germany over 9⅜ million tons, Italy over 9 million tons, Sweden nearly 4 million tons, Russia nearly 3¼, Egypt, Spain, and Denmark, each over 2½ million tons, and the Netherlands and the Argentine each over 2 millions. Adding the 3,246,300 tons exported in the form of coke and manufactured fuel, and the 19,713,907 tons shipped for the use of British and foreign steamers engaged fn foreign trade, the total quantity of coal which left the country was 86,037,006 tons.

The amount of coal remaining for home consumption was 177,737,306 tons, or 3·949 tons per head of the population. 35,924,723 tons were used in the manufacture of coke and briquettes, and 19,463,471 tons in the blast furnaces for the manufacture of pig iron, as against 35,704,971 tons and 18,742,464 tons respectively in the previous year.

During the past thirty-seven years (1873-1909) the total value of the minerals raised amounts to £2,981,116,000, and of this sum coal accounts for £2,467,976,000, or 82¾ per cent.

6,856,407,000 tons of coal have been raised in that period; and of this amount 1,575,998,000 tons, or nearly 23 per cent. of the total production, have been shipped abroad as exports in the form of coal, coke, and manufactured fuel, and as coal used for steamers engaged in foreign trade.

THE ROYAL SCHOOL OF SILK INDUSTRY AT COMO.

The executive committee of this important School (Regia Scuola di Setificio)—which was established by Royal Decree in 1904 for the purpose of giving technical as well as practical instruction in the textile arts, dyeing, etc., to students wishing to qualify themselves for posts as managers, superintendents, designers, etc.—have just made an official inspection of the new building to which this institution will be shortly transferred from the present temporary premises. Beautifully situated on the Viale di Lecco at Como, the centre of the silk industry of Lombardy, the new school will be certainly one of the most important of its kind in Europe.

The laboratories for general and technical chemistry, with special reference to the art of silk dyeing, are provided with all the latest appliances and instruments of precision for testing silk, etc., as well as for experimental research. Besides instruction of students, manufacturers will be able to obtain at these laboratories reliable analysis and tests of their materials and products.

Commodious class-rooms for instruction in weaving, mechanical drawing, natural history, etc., as well as a microscopical laboratory, are also provided. Besides offices, council rooms, and an extensive technical library, nine rooms will be devoted to an industrial museum.

For practical instruction there will be weaving-sheds containing twelve hand-looms and twenty-four power-looms, as well as other machinery used in the manufacture of silk, mechanical workshops, etc. This part of the establishment will be under the guidance of a practical works-manager, who will be assisted by two competent foremen.

The course of instruction is divided into three branches, viz.:—(1) weaving; (2) dyeing, printing, etc.; (3) drawing and designing.

Evening classes will be also provided for working-men.

The instruction in the first department will embrace the following subjects:—Natural history, working of textile fibres, elements of chemistry as applied to dyeing, natural science, mechanics (including practical workshop instruction), mechanical and ornamental drawing, French, English or German, book-keeping, and the elements of commercial and industrial jurisprudence.

The instruction in the second department comprises natural history, the preparation of textile fibres, the elements of weaving, general and analytical chemistry applied to dyeing (with practical instruction), practical mechanics, French, English or German, book-keeping, and the elements of commercial and industrial jurisprudence.

In the third department instruction is given in practical weaving, ornamental drawing, designing, the history of the textile arts, French, English or German.

The course of instruction in each department covers a period of three years. The fees are very moderate, and students who pass all the examinations receive a diploma of "expert" (perito) either in weaving, dyeing, or design.

PEARLS AND THE PEARL-FISHERIES OF BAHREIN.

The whole wealth of the island of Bahrein in the north-west of the Persian Gulf depends upon pearls, and this is also true of the adjacent mainland coast-line. During the year 1909-10 the pearl trade was most flourishing. The prices averaged about 30 per cent. higher than in the preceding year, and showed an upward tendency throughout the season, enabling old stocks to be got rid of and the season's catches to be readily disposed of. Bahrein is also a centre of distribution of many articles for the mainland, the more important of these being rice, coffee, kerosene, sugar, piece goods, ghee, spices and tobacco.

But the governing factor is the pearl supply, and

this, it may be observed, is generally insufficient to meet the world's demand. Any revival of prosperity in Europe and America is immediately followed by a corresponding rise in the value of pearls. During bad years of recent date enormous drops have, no doubt, occurred, and when money is scarce pearls have been a drug on the market. But, on the other hand, the average price of good quality pearls during the last thirty years has quite doubled. In considering the future possibilities of Bahrein it is worth noting that its population is close on 100,000 inhabitants, and all signs seem to point to an increase for the next ten to twenty years, at the rate of about 3 per cent. per annum. This increase is chiefly in the poorer classes, who are attracted from other countries by the comparatively high rates of wages, and the freedom from oppression due to British protection. But though the increased use of luxuries during the last few years has been noticeable in the town of Manama, and among the richer inhabitants of Bahrein, consequent upon their visiting Bombay to dispose of their pearls, no symptoms of general improvement are observable in the lot of the poor, who continue to live contentedly in their mat and palm-date huts.

The rise in the cost of living continues steadily. Captain C. F. Mackenzie, the Political Agent, says he has been told by old inhabitants that some forty years ago the richest people in Bahrein only owned about £5,000, while at the present time there are one or two whose property is valued at £66,000, and several are worth between £6,000 and £7,000. The increase in cost of living during the same period has amounted to about 400 per cent., this being due almost entirely to necessities of life having increased in value, and also to a larger consumption of rice, flour and animal foods, in addition to the cheap dates which years ago formed a much greater percentage of their staple food than now. From this point of view, therefore, an increase in the money value of the trade may be expected.

Beyond pearls there is only one article which can be termed a natural export, and can help in the prosperity of Bahrein, and that is the pearl oyster-shell, which is exported in large quantities to Hamburg. Formerly these shells were shipped to London, but owing to better machinery and greater facilities (thirteen of the Hamburg-America steamers having touched at Bahrein during the year) practically the whole of the trade has been transferred to Hamburg. The trade is now nearly at its zenith as regards quantity, but it will probably improve in value.

Captain Mackenzie remarks it is a pity that no British firm can see their way to sending a representative to Bahrein for the pearl season. He mentions, in illustration of the sort of business that might possibly be done, the case of a member of a Paris firm, who has regularly come to Bahrein for the last four seasons, and whose transactions have amounted to £12,000, £23,000, £36,000, and £266,000 respectively. This includes buying and reselling perhaps three or four times in the course of the season, so the actual capital employed was not nearly so much. He is able to get the best available information by telegraph direct from Paris, which enables him to effect his transactions on much more substantial grounds than his rivals. The profits made by him last year were estimated at about 6 lakhs of rupees (£40,000), results which, although effected in an exceptionally favourable year, have induced his firm to send out another representative to Debaï.

HOME INDUSTRIES.

Passenger Ships and Life-Saving Appliances.—Some misconception has been caused by the model of the "Olympic," of the White Star line, now to be seen at the Piccadilly Hotel. This model shows only sixteen boats, fourteen life-boats and two dinghies, and it has been pointed out that this is a quite inadequate number of boats for a vessel carrying 3,400 souls. At most not more than sixty persons could be safely carried in each boat, which means that the "Olympic" ought to have fifty-six boats if, with a full ship, all have to leave her. It is not alleged that in addition to the sixteen boats there are to be collapsible boats and rafts, and if they were provided they would not be a satisfactory substitute for life-boats. But inquiry shows that there is no ground for alarm. It was, of course, highly improbable that the White Star line would send a 50,000-ton passenger ship to sea without a proper number of boats, and very unlikely that they would rely, or be allowed to rely, upon the theory that the vessel will be unsinkable. The unsinkable ship has still to be constructed. The fact is, that whilst the model only shows sixteen davits, they are to be quadrant davits, that is to say, each will be able to carry four boats, which means sixty-four boats in all, an ample and even excessive provision against disaster. It should, however, be pointed out that this full supply of boats is not required by law. The Board of Trade is supposed to inspect every new vessel before she leaves port, for the purpose of seeing, among other things, that she has adequate boat accommodation to carry the full complement of passengers and crew, and the rule defines with precision what is considered adequate. But this very important question has not been dealt with by the Government for years. There is a statutory maximum, and the boats of every ship above 10,000 tons are settled separately. But this means chaos. The present maximum was fixed at a time when a 10,000-ton steamer was a very rare vessel, the great majority of even the largest passenger steamers being of smaller tonnage. The "Olympic" is to be of 50,000 tons, yet the maximum, as laid down by the Board of Trade, is unchanged. It is obvious that a maximum which might have been, and no doubt was, quite adequate to the requirements of safety when there were no vessels over 10,000 tons, must be quite inadequate for vessels of

40,000 or 50,000 tons; and it may be hoped that, now its attention has been called to the matter, the Board of Trade will lose no more time in revising the regulations that deal with boat accommodation. There are several other matters connected with life-saving at sea which require the prompt attention of the Government. For example, it is useless for a vessel to have the best conceivable boats if they cannot be promptly and safely lowered into the sea. This can only be assured if the lowering gear is constantly inspected and tested, and there is good ground for the belief that this most important duty is neglected on many passenger ships, where, if the life-boats had to be lowered suddenly, it would be found that the gear would not work, and if ultimately they got into the water as likely as not the boats would be found to be unseaworthy.

The Port of Manchester.—The growth of Manchester as a port continues. A few days ago the latest and largest of the Manchester docks, No. 9 Dock, Salford, had all its berths, on both sides of the dock, occupied by steamers loading and unloading cargo. The magnitude and variety of the trade may be indicated by some particulars of the vessels in the dock. One steamer, of 3,174 tons, was discharging grain from Karachi into the transit sheds. Another, of 2,636 tons, was discharging a cargo of paper and pulp from Newfoundland. The paper was conveyed to warehouses for local distribution, whilst the pulp was distributed by rail and barge to Lancashire paper mills. A third steamer, of 3,253 tons, was taking on board a cargo of Manchester piece goods and general merchandise for Bombay, and a fourth was receiving similar cargo for the Persian Gulf, Port Sudan, and other Red Sea ports. A fifth was discharging cotton from Alexandria, and a sixth was passing into the sheds a heavy general cargo, which included a large consignment of American apples for the Christmas market. At the open quay a full cargo of timber was being discharged on to the wharf and into the railway trucks *ex* a steamer from Riga, whilst another, from Baltic ports, was landing timber and wet pulp. A Glasgow steamer had brought a cargo of redwood planks from that city for delivery to firms in the Manchester district, and a sailing vessel was berthed at the quayside, whilst a banana boat was in dock having her refrigerators overhauled.

Wheat Growing.—The experience of 1910 has shown that farmers were premature in assuming that the price of wheat would remain at figures which mean profitable cultivation. The markets of the two or three preceding seasons had been so favourable, and so strong was the confidence in the future, that the restoration of inferior grass land to tillage had been contemplated if not actually begun. But the adverse changes in the wheat and barley markets have caused great depression in countries where tillage is the foundation of the farming system, nor is there much likelihood of early recovery in prices, seeing that the World's wheat crop in 1910 comes out very nearly as large as in 1909—viz., 459,100,000 qrs. against 459,300,000 qrs. The consumption requirements of both years were much below these figures, so that at the present time there is more than sufficient wheat in the world for its wants. It was too hastily assumed by our farmers that the remarkable shrinkage in the wheat exports from the United States must mean considerable and permanent improvement in prices. Insufficient allowance was made for the great expansion of the area under wheat in Russia and the Argentine, not to speak of the Dominion. It seems probable that in normal seasons, and for many years to come, the supply will be fully equal to the demand, and that prices in the wheat market will not leave a satisfactory margin of profit for the English grower.

Fires and Sprinklers.—It may be taken that 1910 will show good results in the case of most British fire insurance companies. Losses abroad have been comparatively light, and in the United Kingdom there have been few very serious fires. For some years past the fire offices have shown a very low home loss ratio, and this favourable experience is attributed largely to the growing protection of a great variety of risks with automatic sprinklers. The installation of these appliances in this country was for many years practically restricted to textile factories, but during the last few years they have been freely installed in a much wider variety of buildings. Experience seems to show that the substantial allowances made where sprinklers are in use are warranted.

The Australian Wool Clip.—In the season 1909-10, ended on the 30th June last, the exports of wool from the Commonwealth amounted to 1,921,705 bales, a record clip. But this year shows a large increase even upon these figures. A splendid season, a larger number of sheep shorn, good lambing, and the greater weight of wool cut from the sheep, have combined to produce a clip for the present season of about 2,125,000 bales, and this is about what the export may be expected to be. Since the lists were closed for the last London auctions, the arrivals have amounted to 118,417 bales, of which 60,000 bales have been forwarded direct from ship to consumer. Of the total, more than 44,000 bales are from South Africa, and exports from the Cape during the present wool year, which ends on December 31st, will show a big advance on 1909. On January 17th the first London auctions for 1911 will begin, and it is expected that about 200,000 bales will be available, including the 8,000 bales brought forward from the last auctions. Bradford will be in no want of wool this season.

Malleable Iron.—The malleable ironmakers, or most of them, in the west of Scotland have held another meeting to discuss the formation of a pool,

but have again adjourned without an agreement being arrived at. The sixteen firms which constitute the West of Scotland Malleable Ironmakers' Association, have been considering a scheme which would allot them shares in the production on the basis of their past output. Any excess of tonnage over these allotments would require the payment of a certain sum per ton into the pool, out of which those firms whose output failed to come up to their allotment would be compensated. This novel arrangement was intended to apply both to the home and export trades, but there are many difficulties in the way of its acceptance, not the least being the keen competition of some half dozen outside concerns. It is probable that if an arrangement is ultimately arrived at it will, anyway at the outset, embrace only the home trade.

NOTES ON BOOKS.

COMPULSORY WORKING AND REVOCATION OF PATENTS. By Ernest Lunge. London: Stevens and Sons, Ltd., 1910. 3s. 6d.

Mr. Lunge was one of those who objected to the system of compulsory working introduced by the Patents and Designs Act, 1907. His present work, while intended chiefly as a handbook to the practice and procedure under the Act, is also to a considerable extent a protest against the principle. It is evident that the author has found nothing in the two years' experience of the Act to modify his opinion of it. The first chapter of the book is an interesting antiquarian disquisition on the origin of the patent grant. Mr. Lunge quite correctly points out that the original condition for the grant was the working of the monopoly, not novelty of invention. The analogy, however, between the old idea of rewarding the introducer of a new industry—basing that reward on the fact that the industry was really introduced—and the modern notion that a man who has obtained a monopoly for his new invention should not be permitted to exercise that monopoly in restriction of the public rights, but should be compelled to work his invention in the country—this analogy, it must be admitted, is somewhat strained. But Mr. Lunge's notes on the ancient system are none the less interesting. The Tudor grants of patents of monopoly were sometimes merely benefactions to court favourites, but were in the main actually intended to encourage the introduction of new manufactures. Such manufactures were sometimes *inventions* in the old sense of the word, that is to say, the introducer had found an industry flourishing abroad and had brought it into this country; and sometimes *inventions* in the modern sense of the word, that is to say, he had discovered a new device or method of manufacture. The former were the more numerous and the more important. Then in 1623 the Statute of Monopolies was passed to restrict the abuses which had encumbered the practice, and monopolies were abolished, except to reward the introducers of new manufactures. The result was the growth of the whole patent system, which was turned into a means of rewarding and encouraging scientific and technical discovery, and the original reason for the granting of monopoly patents entirely disappeared.

There is a good deal of work which might yet be done on the early history of the Patent Grant. Mr. E. W. Hulme, the Librarian of the Patent Office, has done much; but, so far as is known to the writer of the present note, no effort has yet been made to complete the very valuable, yet defective, list of early patents published by the late Bennet Woodcroft after the first great reform of the Patent Law in 1852. The chronological index of old law patents commences with the year 1617. This is merely an arbitrary date, which appears to have been arrived at from the fact that a certain record of grants under the Great Seal, known as the "Docquett Booke," was begun in that year. Notices of the earlier grants must be sought for in the various indexes of the Public Record Office and in the published calendars of State Papers. Nor is Mr. Woodcroft's index quite complete for the period it professes to cover, no notice being taken of petitions for protection of a less formal nature than Letters Patent under the Great Seal. In olden days the royal protection was conferred in different ways, and it will probably never be possible to make anything like an accurate list of the ancient grants. Perhaps such a list would serve no useful practical purpose, but it would be of considerable historical interest.

The second chapter, on "Compulsory Working in the Present," deals with the modern practice in foreign countries, and includes a little discussion as to the bearing of the system on the great question of Protection *v.* Free Trade. The rest of the book treats of the procedure and practice under the Act.

GENERAL NOTES.

COTTON FROM BRAZIL.—In considering the sources of cotton supply outside the southern states of America, the potentialities of Brazil are often overlooked and underestimated. Mr. H. Priestley, who has just returned from the cotton-growing districts of Brazil, directs attention to them. It will surprise many to be told, on his authority, that there is a larger cotton-growing area in Brazil than in the United States, although the amount of cotton actually grown in Brazil is barely one-third the quantity grown in the United States. Millions of bales more could be grown in Brazil if the cotton users of Lancashire would only interest themselves in the matter. The Germans are quite

alive to the possibilities of the country in the way of cotton growing, and within the last four months a wealthy German syndicate has secured three large tracts of land in three of the cotton-growing provinces of Brazil. Mr. Priestley says (and he has had practical experience in cotton growing in one of our colonies from which much is expected, namely Northern Nigeria) cotton grows beautifully in Brazil. There are practically no pests, and, if native labour is not very abundant, plenty of Italians are available. Brazil would seem to offer the most promising field for cotton growing outside the United States.

THE TRANSVAAL GOLD OUTPUT. — The figures bearing upon the gold output of the Transvaal for 1910 bear eloquent testimony to the growth of the gold-mining industry in the Transvaal. In his first edition of "The Gold Mines of the World," published in 1902, Mr. J. H. Curle predicted that before very long an average yield of £25,000,000 might be expected. In the year prior to the war the output was valued at £15,141,376. In 1908 the value had risen to £28,810,000. It is estimated that the value of the output for 1910 will reach £31,850,000. For the eleven months ended November 30th, it was £29,280,137. Prior to the war, as now, the problem how to get a sufficient supply of native labour was one of the most difficult with which the mining authorities were concerned, and, notwithstanding the greater use of labour-saving appliances since the war, the rapidly-growing output has required an ever-increasing number of native labourers. Before the war there were about 80,000 able-bodied natives working in the Rand mines, and, for each new stamp dropped in a mine, ten more natives were needed to supply it with ore. Writing in 1902, Mr. Curle assumed—as so many new mines would soon be starting work—that by 1904, 150,000 men would be needed in the Rand, but at that date nothing like that number were at work, and Chinese were imported. The Chinese have now been nearly all repatriated, and last month the number of natives at work in the mines was 178,027, an increase of some 29,000 upon the figures of 1909.

THE LIBRARY.

The following books have been presented to the Library since the last announcement:—

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MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

January 18.—John C. Medd, M.A., "The Dutch Labour Colonies." Lord Reay, G.C.S.I., G.C.I.E., will preside.

January 25.—Horace M. Wyatt, "Motor Transport in Great Britain and the Colonies."

February 1.—Philip Joseph Hartog, M.A., B.Sc., "Examinations and their bearing on National Efficiency." The Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., C.I.E., Vice-President of the Society, will preside.

February 8.—Captain A. J. N. Tremearne B.A., D.Anth., "Some Nigerian Head-Hunters."

February 15.—George A. Stephen, "Modern Machine Book-binding." John Murray, J.P., D.L., F.S.A., will preside.

February 22.—Professor J. Wertheimer, B.Sc., B.A., "Water-Finders."

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

January 19.—Reginald Murray, "Banking in India."

February 9.—R. A. Leslie Moore, I.C.S. (retd.) "Indian Superstitions."

March 16, April 27, May 25.

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

January 31.—F. Douglas Osborne, M.Inst.M.M., "The Tin Resources of the Empire."

February 28.—The Hon. Sir Richard Solomon, K.C.B., K.C.M.G., K.C.V.O., K.C., M.A., High Commissioner for the Union of South Africa, "The Resources and Problems of the Union of South Africa."

April 4.—Captain R. Muirhead Collins, C.M.G., "Australia and her Resources."

May 9.—F. Williams Taylor, "Canadian Banking."

Cantor Lectures.

Monday evenings, at 8 o'clock:—

Frederick Wedmore, "Etching": 1. "The Old Masters;" 2. "Modern Etching." Two Lectures.

January 23, 30.

Professor Adrian J. Brown, M.Sc., "Brewing." Four Lectures.

February 6, 13, 20, 27.

Professor J. A. Fleming, M.A., D.Sc., F.R.S., "Applications of Electric Heating." Four Lectures.

March 6, 13, 20, 27.

Alfred E. H. Tutton, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

May 1, 8, 15, 22.

Dates to be hereafter announced:—

Frank M. Andrews, "Architecture in America."

Arthur Charles Davis, F.C.S., Assoc.Inst.C.E., "The Manufacture and Testing of Portland Cement."

George B. Heming, "Art Education in Jewellery and Goldsmithing."

Colonel Charles Edward Cassal, V.D., F.I.C., "The Adulteration of Food."

Dr. Leonard Hill, F.R.S., "Caisson Sickness and Compressed Air."

Sir William Abney, K.C.B., D.C.L., D.Sc., F.R.S., "The Quantitative Measurement of Colour-Blindness."

Hal Williams, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

Noel Heaton, B.Sc., F.C.S., "The Production and Identification of Artificial Gems."

Sir Thomas Henry Holland, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India." Lord Avebury, D.C.L., LL.D., F.R.S., will preside. (Indian Section.)

MEETINGS FOR THE ENSUING WEEK.

Monday, January 2...Chemical Industry (London Section), Burlington House, W., 8 p.m. Mr. James P. Ogilvie, "The Determination of Sucrose (Cane Sugar) in Sugar Factory Products by Clerget's Process using Invertase as Hydrolyst."

Geographical, in the Theatre, Burlington-gardens, W., 3 p.m. (Juvenile Lecture.) Mr. F. T. Bullen, "Deep-Sea People at Home."

British Architects, 9, Conduit-street, W., 8 p.m. Sir Henry Tanner, "The New General Post Office."

London Institution, Finsbury-circus, E.C., 4 p.m. (Juvenile Lecture.) Mr. F. Martin Duncan, "Spring and its Studies."

Tuesday, January 3...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Professor Silvanus P. Thompson, "Sound: Musical and Non-Musical. Lecture III.—Reception of Sound."

Photographic, 35, Russell-square, W.C., 8 p.m. Dr. C. Atkin Swan, "The Practical Side of Alpine Photography."

Wednesday, January 4...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. (Juvenile Lecture.) Professor A. M. Worthington, "A Study of Splashes, conducted by the aid of Instantaneous Photography." (Lecture I.)

London Institution, Finsbury-circus, E.C., 4 p.m. (Juvenile Lecture.) Mr. F. Martin Duncan, "Summer—the Pageant of Nature."

Thursday, January 5...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Professor Silvanus P. Thompson, "Sound: Musical and Non-Musical. Lecture IV.—Combination of Sounds."

Philatelic, 4, Southampton-row, W.C., 6 p.m. Mr. A. Léon Adutt, "The Stamps of the Cayman Islands."

Friday, January 6...Women's Aerial League (at the Royal Society of Arts, John-st., Adelphi, W.C.), 3 p.m.

London Institution, Finsbury-circus, E.C., 4 p.m. (Juvenile Lecture.) Mr. F. Martin Duncan, "Autumn and Winter—the Web of Life."

Geographical, in the Theatre, Burlington-gardens, W., 3 p.m. (Juvenile Lecture.) Mrs. Vassalt, "An English Lady's Experiences in Annan."

Saturday, January 7...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Professor Silvanus P. Thompson, "Sound: Musical and Non-Musical. Lecture V.—Registration of Sounds."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 11th, 5 p.m. (Juvenile Lecture.) Professor ARTHUR MASON WORTHINGTON, C.B., M.A., F.R.S., "A Study of Splashes, conducted by the aid of Instantaneous Photography." (Lecture II.—The Splashes of Solid Spheres.)

Further particulars of the Society's meetings will be found at the end of this number.

JUVENILE LECTURES.

On Wednesday afternoon, January 4th, Mr. ARTHUR MASON WORTHINGTON, C.B., M.A., F.R.S., Professor of Physics in the Royal Naval College, Devonport, delivered the first lecture of his course on "A Study of Splashes, conducted by the aid of Instantaneous Photography."

The lecturer began by showing on the screen the curious radial marks made by drops of water and mercury striking a plate of smoked glass. It was the examination of these marks by a schoolboy that first drew attention to the subject. Such a splash is much too quick to be photographed by an ordinary cinematograph. We require a spark of very short duration. The lecturer showed by means of a whirling disc that some electric flashes are not of short enough duration, but the flash of a Leyden jar discharged through thick wires is short enough and may last for not more than three-millionths of a second—quite long enough, however, to give brilliant photographs.

The apparatus was then shown by which such a spark could be produced exactly when it was wanted (within about two-thousandths of a second), and made to illuminate a splash at any desired stage. The splash takes place in a dark room with a camera looking at it, and the camera photographs the stage of the splash that has been reached when it is suddenly illuminated. Each photograph is taken from a separate but exactly similar splash, and thus the whole procedure is followed step by step.

The first photographs shown were, however, taken without a camera at all, by letting a drop of mercury fall on to the photographic plate itself and lighting it up by a spark vertically above it. From these shadow-photographs the well-ordered but complicated behaviour of the drop on striking the plate was easily followed.

It was explained, and made clear by experiments, that the surface of the liquid behaves like a stretched elastic skin which pushes back all convexities and protuberances, and pulls out all hollows and dimples. Also this skin-tension causes any cylindrical rod of liquid, or any such rod bent round into a ring, to divide or topple into a row (or ring) of equal, equidistant drops, whose number depends on the length and thickness of the rod. From the places where the drops begin to form jets shoot out, and the jets themselves topple into droplets. The smooth edge of a breaking wave, and the edge of the crater thrown up by a rain-drop falling into a pool follow the same law.

The splash of a drop falling into water was followed from beginning to end. It was seen to excavate a perfectly spherical hollow many hundred times larger than itself, over the interior of which the original liquid of the drop was spread out as a very thin lining. Afterwards this is all swept together again, and the original drop emerges at the top of a little column, which again descends and again rises.

With larger drops falling from sufficient height the crater thrown up closes on account of the surface tension and forms a bubble which may remain floating on the surface. Such a bubble is built in less than two-hundredths of a second. The big drops of a thunder-shower give rise to bubbles built in this way which often remain floating on the surface of a pool.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A Meeting of the Indian Section was held on Thursday, December 15th, 1910, Sir WILLIAM LEE-WARNER, G.C.S.I., presiding.

The paper read was—

THE TAJ MAHAL, AGRA, AND ITS RELATIONS TO INDIAN ARCHITECTURE.

By ROBERT F. CHISHOLM, F.R.I.B.A., F.S.A.

The Taj Mahal, situated in India on the left bank of the River Jumna, a short distance from Agra, is, on account of its beauty and costliness, one of the wonders of the world. It is the tomb of Argamand Banu, the favourite wife of Shah Jahan, who constructed it in the year 1631. He himself passed away in 1658, and his remains lie beside those of his queen.

The plan and section show the form of the building and the general arrangements. The building stands on a platform 18 ft. high and 313 ft. square with four minarets at the corners, each 133 ft. high. The building, which is 186 ft. square, with the corners cut off, occupies the centre of the platform.

The height of the façade in the centre is nearly 100 ft. above the level of the platform, while the apex of the dome rises to nearly twice this height. The interior contains an octagonal chamber in the centre about 50 ft. across, with passages leading to four smaller chambers at the angles. The whole of the interior and exterior consists of pure white marble inlaid with agate, bloodstone, jasper, black marble, and lapis-lazuli in that form of Florentine mosaic known as "pietra dura."

This is all the technical description of the tomb that I propose to give you, because my object in this paper is to show you wherein the secret of the great beauty of this monument lies, a beauty which is dependent not only on its immediate surroundings, but on the state of the weather, the time of day, and even the artistic discernment of the beholder, which may account in a great measure for the differences of opinion among visitors. Doubtless all buildings are affected in the way I have suggested, but when you understand the secret of the Taj you will understand why this building is pre-eminently so.

The only two points to which I would call your attention just now are, first, the difference in the outlines of the great dome and the subordinate domes, and, secondly, the fact that no work above the roof serves any useful purpose. Perhaps there is no building in the whole world which has received such extravagant praise from travellers, and no building in the world of which pictures, photographs, and models convey so poor an idea, the reason being that the high position to which most travellers raise it is due more to its unique, almost magical appearance, than to either its architectural merits or to an appreciation of its intrinsic value. In regard to its architectural merits, buildings can be found in India surpassing it in every direction: thus for size and boldness of construction the Taj falls far below the Gol Gombez at Bijapur. This building covers a square of 135 ft. 5 in.; Santa Sophia, at Constantinople covers a square of about 130ft.; St. Peter's, at Rome, about 126 ft.; and St. Paul's, London, 95 ft. In wealth of intricate detail and great delicacy of finish it is surpassed by the Jain temple at Dilwara, on Mount Abu, in Rajputana; in size, unity, and symmetrical arrangement by the great Jumna Musjid at Delhi; in constructive skill by the ingenious doming of the mosque of Sher Shah in the old Kila at Delhi; in magnitude and extent by the great Sivite Temple of Madura, South India, and in strict conformity to the canons of pure architectural decoration by the Muntapum on the building known as Jehanghir's Mahal at Agra and the Bir Bul at Fatehpur Sikri.

I was expressing somewhat similar views to a lady friend who seemed to me to be indulging in rather extravagant praise of the building, when she said, "I understand exactly what you mean, but go and see the building itself. I cannot explain it; it is unlike anything I have ever seen." Thinking she was drawing on her imagination I mentioned the matter to a very prosaic male acquaintance, who astonished me by saying, "Mrs. —— is quite right! Go and see the building; it is ghostly!" I was in no way convinced; I had seen photographs and models which did not justify such lavish praise. I merely wondered to myself, knowing its costliness, why intrinsic value should be so highly esteemed. In due course I visited Agra, not to see the Taj, but to extend my acquaintance with the exquisite sandstone work of the older period. I was familiar with the fine examples to be found at Ahmedabad, Puttan, Dabhoi, and elsewhere, and I continued to regard the Taj as a costly jewel, exhibiting in all its details the decline and not the zenith of Hindoo Saracenic art. I

surprised the guide I had engaged to take me about by the close attention I paid to the old red sandstone work, and my indifference to the costly gem which gleamed in the distance. After a few days, to the guide's great relief, I decided to visit the Taj. We arrived at the entrance mosque a little before noon. I was so struck with the beauty of its interior that I forgot all about the Taj, when, crossing one of the openings which commanded a full view of it, the sunlit building itself suddenly burst upon me—but that was surely not the Taj! It was not a building at all. But what was it? A painted scene? No. A model? Yes, it must be a model; the real building was doubtless out of sight. "What is that?" I asked the guide. "The Taj," he replied. I smiled incredulously. I was not to be taken in.

Perhaps some of my hearers may have observed a curious illusion which occurs at sea if a boat is approaching from a distance; the men who man the boat look like pigmies, and if nothing intervenes to express distance, and you watch continuously, the men remain pigmies until the cheated sense revolts, and the pigmies suddenly enlarge to full-sized men; to me personally, the illusion remains until the boat is quite close to the ship. Now in some such way I seemed to realise suddenly that what I took to be a model was a building of noble proportions, but this knowledge seemed to increase rather than to diminish the effect of mystery; it was truly, as my friend said, unlike anything I had ever seen—a translucent visionary object, part of the sunbathed atmosphere, all-satisfying in its loveliness. For awhile I stood gazing in the simple enjoyment of the scene, then, as the sense of keen pleasure gave place to a sense of curiosity, I determined not to move forward one step until I had solved, at all events in part, the secret of this almost unnatural effect, and how it came about. First, I observed that all the shadows were in a very high key; the lights on the dark foliage of the cypress trees were deeper than the deepest shadows on the building; again, the windows, which seemed at that distance simple frames, opened into comparatively light, not dark chambers, while the entrance doorway looked like an ink-blot, seeming to mar the general harmony. I felt convinced that this effect was not intended, and looked for other inharmonious notes. These I soon found in the deep shadows of the subordinate cupolas on the roof. As my eyes became more critical, I detected the comparative coldness of the shadows above the roof as compared with those below; the shade of the great dome was grey, while the shadows of the recesses were of a warm amber colour. Everything above the parapet seemed cold and lifeless, while everything below sparkled in the brilliant sunshine, suggesting tones of crimson, citron, green, and orange. Approaching the building, I found it to be in the centre of the large platform of white marble which cannot be seen from the entrance, but the roof, which was doubtless also intended to be of white marble, was covered with that dullest of all dull but useful materials, Portland cement—a deep-toned green-grey! The difference in the effect seems to justify the belief that the roof was intended to throw back on to the dome the maximum amount of reflected light, just as the marble platform on which the building stands throws back the maximum of reflected light on the lower part. You will observe that the face of this platform, viewed from the gateway, appears to be part of the building, an intentional illusion I believe, which adds to the general ethereal effect by the weakening of the shadows due to the distance between the foliage and the building. Examining the windows more closely, I found that the comparatively light appearance was due to a regular pattern of white marble which acted as a white veil and could not be perceived at a distance. As cost was no object I cannot help thinking that if the effect produced was not intentional, the windows would have been filled by elaborate arabesqueing like the screen at Delhi or the Ahmedabad Palm Window. Tracery of this kind would have had a much richer effect, but, of course, it would not have toned the openings to that delicate warm grey. I found also the intensely black spot (the entrance which really opened into the building) to be without a blind or chick, though the two metal rings intended to hold it were in the lintel of the door. Mr. Havell, in his essay on the Taj and its designers, published in the *Nineteenth Century and After*, says that this opening was originally closed by silver doors. If this is true the door-hangings are probably in the frames still; the rings for the hanging of the chicks satisfied me, and I am sorry I did not look further. Again, the four corners of the building are cut off to a considerable extent to avoid the depth produced by simultaneous contrast. Lastly, the effect which would have been produced by mouldings and sunk surfaces in this particular style is here produced by black marble inlay, so that the general appearance is not unlike lace, and at the first glance gives the effect more of a drawing than of a real building. It is difficult to imagine that the attempt to

secure the maximum of reflected light, the systematic heightening of all shadows on the façade and dome, the avoidance of strong contrasts, and the provision for planting heavy foliage around and before the building, were all the result of accident rather than the systematic working out of an artistic idea, and still more difficult to understand how, if that idea originated with the architect of the building, it was not carried out consistently to the finish, instead of being stopped at the point where, owing to the deep blue of the zenith, the strongest reflected light would be required. I do not intend by these remarks to disparage the architecture in any way. I am quite ready to admire the proportions, and to admit that the Taj would be a remarkable building under any light and constructed of any materials. What I desire to point out is that the startling ethereal appearance is not due to scholastic architecture, and could hardly have originated in an architecturally-trained intelligence, for such an intelligence is antagonistic to this principle of subordination, and delights in producing brilliant contrasts; it is rather an artistic thought, the idea of an artist, a man who loved light and could divide it into a hundred shades; a man who said to himself, "I have here practically an inexhaustible purse, the most lustrous material the world can produce, and the brilliance of a tropical sun. I will use my materials as I would paint a picture, subordinating all the deep shadows on the building, so that it will appear ponderous yet cloud-like, rising like a dream-palace out of a garden consisting of the deepest foliage procurable." The effect which the building produces on the observer leaves the artist's success beyond a doubt, for the man with the idea has portrayed materially the subtleties of pictorial values, which neither picture nor photograph can fix; in fact, he did for this style of art what Shakespeare did for the drama of his day, and the Taj will always be condemned or exalted in exact proportion to the perception of the idea.

In order to see clearly that this building was the natural outcome of the architecture of the period we must glance at its history.

The Moghul empire, commencing with Bābar in 1526, lasted till about 1707, a little less than 200 years, and during this period a broad belt of the country from Lahore to Agra came under its immediate sphere of influence. It must be borne in mind that when the Mohammedans conquered India they found in all parts of the country a perfected art of architecture and groups of skilled workmen who were freely employed in all directions, and the Mohammedan ideas which filtered through these workmen gave rise to that mixed form of art named by Mr. Fergusson Hindoo-Saracenic, and if the zeal and energy the Hindoos threw into their work is any indication of the state of their feelings, it is interesting to note the goodwill that seemed to exist between the two races. But there was another influence at work. The commercial relations with all the countries west of the Indus increased during this period, and in proportion as they increased the Hindoo element died out of the architecture, and, at the time the Taj was built, although the actual workmen were Hindoos the feeling and many of the forms were imported from the Bosphorus or Persia. We may conveniently divide the architecture of this period into three classes—first, the pure sandstone work; secondly, sandstone and marble mixed; and, thirdly, pure marble. In architecture the Hindoo disliked the arch as much as the Greek did; both seem to have felt instinctively that an arch always embodies the self-destructive element; an arch is, as it were, always "awake" and never for one moment forgets to exert a thrust. In pure Hindoo art openings are bridged by corbelling, and it is to the strict adherence to this principle that we owe the great sense of repose which their architecture conveys. I will show you the general evolution. [Worked out on the blackboard.]

Perhaps the most beautiful and intricate style of corbelling is to be found at Dabhoi in his Highness the Gaikwar's dominions; as it would take too long to work this out on the blackboard, I have sketched a slide. You see how each corbel supports a column, the column's support strings ending in another corbel, and the spaces between are strutted by panels on which deities are represented. The same hatred of thrust and cross-strain exhibits itself in their domes, which are of low curvature on the exterior. First, the corners were corbelled out to form an octagonal figure, then stone beams were laid alternately square and diagonal until the space was small enough for a single stone.

It is hardly necessary to point out that this style has its limitations; its halls of a thousand columns simply meant that the space required necessitated a thousand points of support. But with the Mohammedans came the demand for greater clear space and greater height, and the consequent introduction of the arch and the true dome. The Hindoo builder never assimilated the arch; indeed, when used as a constructive feature, its lines were ignored and its

decoration had no sympathy with the joints of the work. The arch would be constructed as an arch, but the lines of ornamentation accentuated panelling. It was not so, however, with the dome. From the first they seem to have grasped the fact that, unlike the arch, the self-destructive element is under control, that each ring of a dome properly tied in exerts no outward thrust; hence, under Mohammedan influence, the dome-builders of India attained a mastery over this form unknown and seemingly unappreciated by the builders of the Western world.

You will observe that if it is required to cover a square area by a dome, the section from corner to corner presents a very different aspect from that of the section parallel with the sides, as the corners are wholly unsupported. The methods adopted for supporting the superincumbent mass at the angles differ in different styles and different countries; perhaps the most beautiful and stable was that adopted generally by the Central India dome-builders. This method may be described as the intersection of two squares within the larger square in such a way as to leave a true octagon in the centre. This was further reduced by a figure of sixteen sides before passing to the round. An arch is then thrown from 1 to 2, 2 to 3, 3 to 4, and 4 to 1. Each of these arches is thus intersected in two points. The interior view is very beautiful. You may get a faint idea of what it looks like from the photograph of a Bijapur dome. If an embroidered cloth is thrown over the "eye" the interior effect is very beautiful, and the echo destroyed. A dome constructed of stone can be cramped and dowelled ring by ring, but when constructed of brick. the stability depends a good deal on the strength of the mortar. The great dome at Bijapur has cracked into lobes, and each lobe rests against its opposite neighbour in perfect equilibrium.

The dome of the Taj starts at once from the octagon, and is closed practically at the roof level, so that all work above the roof is merely for show. These domes seem to have been built without centres. Scaffolding and centring in India is formed of bamboos tied together with coir rope, and the form of the arch on the top is made up of brick laid in clay and brought to the correct form with that material. No centre of this description could stand continuous heavy rain. Consequently the size of a dome, if supported during construction on a centre of this kind, would be limited by the amount of work which could be done during the dry months of one year. At Golconda I noticed among the tombs that the last to be built had a very elongated appearance. Going inside to ascertain the cause, I found that it was not a true dome at all. The builders were evidently working on tradition; they had feebly turned in the top until their hearts failed them. Then they had boldly trussed the upper part and left the truss in.

You will understand, when I show you a specimen of the pure Hindoo-Saracenic in sandstone, how the introduction of the arch revolutionised the reposeful feeling of the art. Here is a view of the Muntapum on Jehangir's Mahal in the fort at Agra. Although it is called Jehangir's Mahal, Mr. Fergusson puts the date of its construction much earlier, and I quite agree with him. I also show you a view of the Bir Bul in the same pure style. The most beautiful specimen of the second group, where marble is freely mixed with sandstone, is the famous gateway of the mosque at Fatehpur Sikri. The highest architectural authorities, among whom I may mention Mr. Phené Spiers and Mr. James Fergusson, regard this gateway as one of the most perfect architectural achievements in the whole of India. You will observe here that the arch is the dominant form, and that every Hindoo detail is modified, more or less, to suit Mohammedan and even Western tastes. In the third, or entirely marble group, of which the Moti Musjid or Pearl Mosque is a good specimen, structural propriety has given place to extreme elegance. The little kiosks which formerly crowned an angle, a minaret or a spiral staircase, have become attenuated ornaments; the arches a series of cusps cut in an apparent solid: the columns, pieces of pannelled walling; the capitals and bases, mere strings; and the elaborately-consoled cornice, a plain curved feature. The carving generally is in that Byzantine style of art which was imported from the shores of the Bosphorus, doubtless modified as it journeyed eastwards through the countries west of the Indus.

This cursory glance at the architectural development which extended over three-quarters of a century shows that although the workmen always were, and indeed are now, mostly Hindoos, the style was gradually tempered by Western ideas, and that at the time the Taj was built the Hindoo spirit had almost passed away. The general arrangement of a central dome with four smaller domes at the angles is similar to that found in Humayun's tomb in old Delhi. Mr. Fergusson says of this tomb in his history of Indian architecture:—"Its plan is in fact that afterwards adopted at the Taj Mahal, but

used here without the depth and poetry of that celebrated building . . . It is so very unlike anything else that Akbar built that it is hardly possible it could have been designed by him. It has not even the picturesque boldness of the earlier Pathans' tombs, and, in fact, looks more like buildings a century at least more modern than it is." Now Humayun's tomb is said to have been commenced by Humayun's widow in 1530, and a century later brings us to Shah Jahan, the builder of the Taj.

In Fanshawe's "Delhi, Past and Present" Humayun's tomb is said to have been built by Akbar, commenced in 1556 and finished about 1569. A careful examination of the tomb itself, however, shows two distinct periods. The part first constructed by Akbar—the central dome and the façades—seems to have been overlaid at a much more recent date, while the part finished *last* by Akbar, the small domes and cupolas on the roof, have been allowed to remain as Akbar finished them. In order to bring out this fact more clearly I have made a sketch of the tomb as I think it was originally finished. Observe that the open parapet, which surmounted all buildings up to the end of Akbar's reign, has become a flat inlay of white marble on a plain piece of walling. It is a parapet no longer, but a pictorial inlay of white marble, actually turned down at the angles like a picture-frame, apparently to preserve continuity between the upper and lower cornices, an impropriety which, I feel certain, no architect of Akbar's period would have been guilty of. The great central dome has the drum corbelled out to support the overlay of white marble, which seems to have been spread all over the original work so thickly that it buries the usual floral centre and the metal finial up to the top of the lower member, and it is curious to note that the jointing of the marble is exactly similar to that adopted on the Taj, a broad and narrow course alternating. The two small domelets would end the façade in this style, the parapet, as in the Fatehpur Sikri gateway, ending at about the limit of the cornice, but the applied work is made to run out further and return the parapet vertically down, as I before mentioned, to meet and continue the parapet on the lower level. This overlay alters all the proportions of the façade, and I think it will be conceded, when due allowance is made for a very small imperfect sketch, that the restoration I have attempted is infinitely more like the spirit of Akbar's work than the photograph of the building as it is. A careful examination of the building itself would set these conjectures at rest. The matter is of little importance now, were it not that this building furnished the plan and general arrangements of the Taj, and the two buildings have this remarkable affinity: *both* exhibit *two* distinct periods in the principal features, the façade and the central dome being of one period, and the small domes of another. In Humayun's tomb the older visible parts, the four small domes—naturally the last parts to have been constructed—are much earlier in style than the main dome and façade, the first parts to have been finished; the four small domes on the Taj, also the *last* part to have been constructed, likewise show an earlier date, or, at all events, a return to what would be considered an older form of art.

I am afraid this is a little confusing, but I can make my meaning clearer by taking refuge in conjecture. It is as if the man with the idea had been allowed to experiment with white marble in Shah Jahan's time on Humayun's tomb, and that while he worked, the idea of the Táj grew and became perfected; that he worked only on those features which he intended the Taj to possess—the great dome and the façade. That a successor, knowing Humayun's tomb to be his source of inspiration, but not understanding the principle on which his predecessor worked, constructed the four smaller domes and the lighthouse-looking minarets at the angles of the platform after the man with the idea left. The building would not suffer, in my opinion, if these small domes were removed; as I have pointed out, they serve no useful purpose whatever; the outline would gain in simplicity and the roof, if covered with white marble, would make the great dome a more ethereal object than it is now. In that water-colour drawing you will see what I conceive to have been the intention of the man with the idea, and although no drawing can convey the effect of the building, a comparison with the photographs of the building reveals to my mind no sense of lack of, but a distinct gain in, simplicity and repose.

I have endeavoured to show by this somewhat prosaic dissection that the unique appearance of the Taj Mahal arises from a studied and systematic system of heightening the deep shadows and avoiding all those black patches which destroy a sense of distance. I have endeavoured to show you that its architectural lines were the natural outcome of the styles which preceded it, and that the foreign influence is no stronger in this building than in other works constructed during this period; that the startling effect of the Taj is due to the studied control of light and

shadow to produce what one might almost term a scenic effect in opposition to that produced by ordinary architectural practice, and I also think this effect largely dependent on the extent and quality of the foliage in the surrounding garden, and that the first glimpse of the building should always be from the entrance gateway with the sun or the moon in the zenith. That this effect is in the majority of cases unexpected and startling is beyond question.

Dr. Leitner, in this room not many years ago, speaking of the Taj, compared it to a piece of lacework. "It appeared," said he, "with its dark background of foliage to float in the air, it was more like a dream than a reality." Bishop Heber said it was the conception of giants carried out by goldsmiths. The late Sir W. W. Hunter described it to me as "a stupendous jewel—not a building at all!" But perhaps the best description is that given by Sir Frederick Treves, one of the most recent travellers. "Everyone," he says, "who visits Argamand Banu's tomb for the first time approaches it with curiosity, tinged probably by a faint disposition to be hostile. So much has been written about this wonderful building, so much rhapsody has been lavished upon it that there is some suspicion of over-praise. The claim that it is the most beautiful building in the world is a claim that many at once resent. Its outlines are familiar enough from pictures and models, and it may be that they hardly warrant unrestricted ecstasy. The visitor proposes to himself to put sentiment aside and review the building critically . . . to submit it to a common-sense inspection, for he is inclined to believe the Taj Mahal to be a much overrated monument. He has, indeed, already imagined himself on his return home giving to his friends evidence of his originality by asserting that as for the Taj he sees nothing in it . . . With the first sight of the Taj Mahal there comes only a sense of indefinable pleasure, it is no mere feeling of admiration, still less of amazement. No mere delight in a splendid building, because it does not impress one as a building. There is a sudden vision, and with it a sudden sense of ineffable satisfaction, as if in the place of a marble dome the garden had been filled with divine music. All intended criticism is forgotten; there is nothing that appeals to the judgment or that suggests the weighing of opinions. There is merely a something that touches the finest sense of what is tender, beautiful, and lovable—a white cloud, luminous, intangible, translucent! The secret of the beauty of the Taj Mahal lies in the great arched recesses or vaulted alcoves which burrow deep into the body of the building. These are throbbing with sensitive shadows, and they give the impression that the onlooker can see into the very heart of this gentle palace as one would gaze into the heart of a yellow rose, where leaf by leaf the tints become deeper, warmer and more living. There is ever a sense of something half hidden and half revealed of a tenderness which has deeper depths! . . . It is this abiding suggestion which makes the peculiar glory of the Taj a glory which is beyond the reach of any picture or any model. To many the Taj will be the most beautiful building in the world, while there must be few who would not acknowledge that it is the most loveable monument that has ever been erected." If architecture compared with mere building is really the compensation which man offers to his fellows for robbing them of so much of God's fair work as each building blots out, the sins of the man who inspires such praise as this, must surely be forgiven. Who the man was matters very little; indeed, for all that, it might have been a woman! But whoever it was, receives the gratitude of countless admirers.

It seems to me that a paper like this, though dealing however slightly with one of the most glorious periods of Indian art introduced by a conquering race, would hardly be complete without some allusion to ourselves as the present ruling power. Englishmen are ever ready to point out the shortcomings of their own brothers and sisters, and I have heard most unfavourable comments made about the awful mess we have made generally with the arts in India. I think perhaps as regards the industrial arts a true bill may be found against us, and yet even here, the natives of India themselves have been the greatest sinners. We tempted them with commercialism, it is true, but they showed no disposition to avoid the diet, and a walk through the wealthier quarters of the principal cities will show that many of them gorged themselves. A large and earnest band of ladies and gentlemen have devoted themselves to the problem of conserving the native industrial arts of India, and the Government have always been ready to assist them in every way, but the questions—what is there to conserve? where is it to be found? and how can it be conserved? are not easily answered. When, however, we turn from this to a more extended view, and see the railways, roads, canals, irrigation works, lighthouses, bridges, and other public works which our

fifty years' rule have given to the country, we may rest contented that we have done more for the general advancement of the brotherhood of man, than if we had built a palace in every city, and a Taj in every talook.

When we narrow the field of view to architecture alone, the real scope of this paper, I trust I can show you specimens of art constructed during the past fifty years of which no country need be ashamed, and these are by no means the best specimens of architecture to be found, but the best specimens of which I could obtain photographs. Before showing you these, however, I must, in justice to the Indian workmen, explain that the labour procurable is of a highly intelligent order. In the 'sixties I set some ordinary stonemasons to design and execute granite capitals. I merely gave each a block of granite about 4-foot cube, with instructions to work from a square abacus to a round column. By the kindness and courtesy of Sir Arthur Lawley I am enabled to show you these three specimens of the result.

Individually we may differ as to the direction in which the art of architecture should move. We may think the issue of standard designs a little overdone; that a country covering twenty degrees of latitude, with seacoast, table-lands, and altitudes attaining twelve or fourteen thousand feet, demand a closer study of local conditions; we may regret that medical laws—chiefly made in Germany—may have restricted the output of hospitals, schools, and asylums, but when we look at the actual results of our fifty years' rule, I think, when you see the types of only a few specimens, you will agree with me that we have every reason to congratulate ourselves.

[Here the author showed a series of slides illustrating buildings erected in India during the past fifty years.]

In conclusion, I should like to offer some remarks on the future of Anglo-Indian art in India, but—and this is a great, great but—architecture in India, and, indeed, throughout the world, is entering on an entirely new phase, for that great potentate, ferro-concrete, has been enthroned, and his reign will be a long one. I am a great believer in the unity of ideas. The human body is composed chiefly of bones, flesh, and skin. If we put for these materials, steel, concrete, and porcelain, we would seem to have arrived at the ultimate of all sound durable construction, but the adornment of such a combination is infinite, and will demand the exercise of a new sense of fitness. In what directions the ferro-concrete art will be developed, it is impossible to say. I believe myself we are on the eve of a much more beautiful form of permanent building than the world has yet seen, for the capabilities of the new material seem absolutely inexhaustible—limitless.

DISCUSSION.

The CHAIRMAN remarked that no country in the world lent itself so generously to good architecture as India. In its varied scenery of stupendous mountains, far-reaching sun-lit plains, deep forest gloom, valleys, some clothed with bright crops, others buried in the seclusion of rocks and trees, placid, broad rolling streams, cascades and surging torrents, the builder could find every setting he desired to express his temper and moral feeling in devotional or memorial work. Nature was equally lavish in every accessory, while for many months a cloudless sky showed to the best advantage the work of man. Some beasts of the forest such as elephants were models of strength, while others as the deer and antelopes were models of delicacy and gentleness. Vegetation offered the sculptor a wealth of beauty in the bamboo clump, the lilies that lay on the laps of lakes and pools, or the orchids which draped the trees in the jungle. Ferns of every size and texture, and flowers of varied hue carpeted the ground, while in strength and luxuriance of foliage the teak and the mango respectively could not be rivalled. For suggestions of colour where could such sunsets, rainbow tints, or frowning tempests be witnessed as those of India? The birds of the air built nests of every subtlety of protection and grace of construction. With all these models, the national character, if one might ever apply so generic a phrase to anything in India, gave a particular impulse and direction to her architecture. Centuries of civil war and invasions, and the selfish neglect of her rulers, previous to the establishment of British rule, in failing to offer any resistance to famine, floods, disease, or other natural enemies of mankind, had ingrained in the peoples of India a sense of resignation, patience, self-denial, and a feeling of the irresistible omnipotence of God. Perhaps the same cause accounted for too ready an acquiescence in deception and unreality which affected both the choice of material and the execution of design, and, as the Chief Engineer in Mysore had lately remarked, introduced a slackness into the work of the builders. No doubt national sufferings as well as the enervating climate were opposed to the development of strength and the impulse to action which so characterised the Norman. But the spirit of religion, sometimes, it must be confessed, degenerating into superstition, moved on the face of Indian society, and shed its light and inspiration upon the whole field of architecture, Dravidian, Hindu, and Mohammedan. For building material Nature had supplied the wants of the

Indian with no niggardly hand in the Porbandar granite, the rich red sandstone, marble, and glittering agates, gems and jasper.

It must be confessed that in domestic architecture the conditions of Indian life had offered an easy option, and encouraged a low standard of comfort. Another influence in the same direction was the want of a sense of the dignity of human life. The masses of the people dwelt in the most squalid hovels, and even the well-to-do gentry lived in ill-ventilated, untidy premises, without a thought for sanitary conditions or pleasing effect. When the State built lines for its soldiers, police, or the numerous dependents of a ruling chief, little regard was paid to reasonable comfort and none to architectural effect. The palaces of the Rajas themselves, with few exceptions, displayed no taste, and supplied none of the adornments or comforts which natural pride of high position and public opinion demanded in European countries.

It was in its devotional and monumental work and not in domestic architecture that the heart of India was touched, and made a serious endeavour to express its ideals in stone. And as the Hindu religion differed fundamentally from the Mohammedan, the difference asserted itself in their temples and monuments, just as it did in their customs and habits of life. The Hindu character exhibited itself in exuberant fancy, patient if mechanical labour, and meticulous detail, too often losing touch with the central idea which the architect intended to express. Fergusson constantly repeats his criticism of the Tiruvalur Temple near Madras, in his descriptions of other Hindu buildings: "We may be astonished at the elaboration and evidence of labour, but as an architectural design it is altogether detestable." Even the ordinary sightseer could not help being bewildered at the majority of Hindu temples. If you look at a Norman building you realise strength, or at a revivalist cathedral beauty, or at a Greek Parthenon wisdom. In the Hindu temple the details distract your attention, and frequently you cannot see the forest for the trees. You can form no idea of what the architect intended. There is no central idea, no harmony, and no self-control. There is not even a dedication of the work to a single one of the great Hindu gods, neither unity of worship nor unity of design. The parts are overloaded with numerous idols, and where Nature has been drawn on to supply the models, the most incongruous beasts, birds, and vegetation have been thrown together in a mass—*e.g.*, elephants borne aloft on the heads of puny men, pouring from their trunks streams of water on the divinity seated on a lotus.

Mohammedan architecture speaks with a more certain sound, proclaiming the unity of God, banishing all likeness of man or creature from the surface of the stone, subordinating all details to the central idea, and laying at the feet of the departed soul or of the Creator the grandest tribute which heart, hand, and eye can conceive and execute. In this respect the Taj Mahal stands supreme. This grand triumph of the architect's art was still building when the drowning of his friend King, in crossing the sea from Chester to Ireland, inspired and moved Milton to pour out his soul in Lycidas. The inimitable hand which built the monument in stone to the Mumtaz Mahal (exalted of the palace), wife of the Emperor Shah Jahan, was not less poetical than the master of melody, John Milton, while the work of the former is free from the incongruities marshalled together as fellow-mourners in Lycidas. All the thoughts which can comfort the human soul in the presence of conquering death are expressed on the buildings on the bank of the Jumna, which rise in silence a mile and a half distant from the clang and pomp of the busy fortress of Agra—rest, hope, beauty, and eternity. Mr. Chisholm, from the architect's knowledge, had told them how material and construction lend peace and rest to the great mausoleum with its softened light. The environment heightens the effect of the builder's art. The numerous uplifted pinnacles, as well as the dome pointing heavenwards, tell us of assured hope. Beauty is expressed not merely in every detail, but stamped on the whole design and its execution, the parts being subordinated to the whole, the decoration exquisite and yet subdued and controlled; while the solidity of the material and the pure marble platform, with the stream flowing by in its ceaseless course, until time shall be no more, remind the spectator of eternity. Night succeeds day, and the lamps of heaven flash with softened light on the waters of the Jumna, and still the beauty of the monument is not impaired; nay, it is rather increased by the starry firmament and silver sky. Truly, one feels with Shelley—whose tribute to Keats in his "Adonais" is the most beautiful monument in British verse—as one thinks of the emperor's wife resting peacefully beneath the dome—

> "She is a portion of the loveliness,
> Which once she made more lovely."

Or, again, that the soul of the Mumtaz Mahal, as

> "The soul of Adonais like a star
> Beacons from the abode where the eternals are."

Happily, the Taj does not speak only to the architect, nor only to the Mohammedan. It appeals straight to the heart of all who see it, as no other building in the world appeals; and Indian architecture has enriched the inhabited universe, and proved that the highest ideals and dreams of human genius can be expressed in stone as well as verse. The thanks of the Society were due to Mr. Chisholm for helping them to realise why the Taj exercised so potent an influence on all who beheld it.

Sir George Birdwood said:—I feel I must take a part in the discussion, having joined Sir William Lee-Warner in insisting on Mr. Chisholm favouring the Indian Section of the Royal Society of Arts with

the paper that has held our gratified and grateful attention during the past hour. Mr. Chisholm is an architect of marked ability and skill; and of extensive knowledge, at first hand, of the historical building styles of India, combined with an exceptional insight of the merits of Indian art, and an enthusiasm for it as sane and discriminant as it is spontaneous and stimulating; and those among us who know Mr. Chisholm personally well foreknew how completely he would carry the present meeting with him in his clear and convincing technical descriptions of the material features of the so-called Taj Mahal, and his subtle analysis of the sources in those features of something of its irresistible and incontestable charm for all whose eyes have once been quickened by the pure and faultless apparition of it to a true and, for many of us, a passionate sense of its incomparable spiritual beauty.

But I hesitate to speak on an architectural subject, for not only is architecture a department of fine art but of high applied science also, and, alike as fine art and civil engineering, it is entirely beyond the range of my responsible criticisms, limited as they are to the subjects of applied art, that is the arts and crafts, otherwise the industrial arts. To express this in a metaphor,—I dare not look up into the face of "the blue-eyed Maid," and only bow down myself humbly to the fair latchet of the straps of her sandals; and all my life long my responsible interest in the so-called Taj Mahal has been in its mosaics and other decorative details.

But before I pass to these, let me say in explanation of the point of view from which I approach such questions, that, in my opinion, what we differentiate as Saracenic art has really little to do with the Saracens. None of the Semitic races ever invented a building style that could be classed as architecture, *i.e.*, architecture regarded as a fine art; and no tribe of pure Arabs has ever shown inventive ability even in the practice of the applied arts. The Assyrians and the Babylonians, like the other Semitic races, betray a keen appreciation of the sumptuary applied arts, in their clothing and jewellery, their furniture and the embellishment of their palaces, their armour and horse trappings, and chariots, etc. But their building style never rises beyond civil engineering; and it is almost certain that their applied arts were derived from the aboriginal Turanian populations of Anterior Asia, such as the Akkads and Hittites, peoples apparently allied to the Chinese and Japanese. Passing to the Jews, we know that the so-called "City of David"—really a fortress—and "Solomon's Temple," and the Palaces of David and Solomon, and "the House that is in Lebanon," were all built, and decorated, and furnished throughout, by carpenters and masons, and other handicraftsmen sent down to King David and his son Solomon, by Hiram, King of Tyre, expressly for the purpose of erecting these buildings; all of which is set out and in great detail in the Biblical "Books of Samuel," and "Books of Kings": and these handicraftsmen were all mongrel Turanians, cognate with the Hittites of Syria and the Akkadians of Mesopotamia [*cf.* 1 Chron. iv. 14, "the valley of (Çanaanite) craftsmen"]; this going far to explain why the restorations of "the House that is in Lebanon," given by scholarly and learned European architects, so closely recall the photographs shown here last year by Mr. J. Claude White of the alpine palaces, fortresses, and monasteries of Bhutan and Sikkim, and Thibet. As for the Saracens, they never of their own initiative raised a single building that could be called architectural. Their *Kaaba* itself, the cynosure of pan-Islam, was built by a Greek, and its very name is Greek, *κύβος*, "a cube." To this day all the so-called "arabesque" embroideries produced in Egypt are the work of Greeks [*cf.* Acts xix. 24, Demetrius, "a silversmith," and 2 Timothy ii. 14, Alexander "the coppersmith"]. The fact is, the Saracens wherever they went on their ever-victorious way, like the Assyrians and Babylonians before them [*cf.* 2 Kings xiv. 16, Jeremiah xxiv. 1], kidnapped and employed the local handicraftsmen of the countries they subdued to do all their artistic work for them, in architecture, furniture, clothing, armoury, etc. These were Greeks, or Hellenised Egyptians, Syrians, and Persians [Aryans, like the Greeks themselves]; only these Greeks had to adopt their designs to the uses, the manners and customs, and above all to the rigorously monotheistic religious prejudices of their Muslim conquerors. It was in this way that the Byzantine art of Northern Africa and Anterior Asia was gradually transformed into what we call "Saracenic Art": its first, full, and felicitous inflorescence being seen in the "mosque" of Old Cairo; and later in the "mosque," now the Cathedral of Cordova; and later still in the Cathedral of St. Sophia, now the great "mosque" of Constantinople. Similarly, the Islamite Pathans, Mongols, etc., on subjugating Hindustan and the Dakhan, largely employed alike Persians and Hindus in the construction of the palaces and tombs requisitioned by them; and so sprung up all over India such types of Indo-Saracenic art as the *Masjid** at Peshawur, the columns of it reproducing those of the Mosque of St. Sophia; the Pathan tombs of Old Delhi; and the Moti *Masjid* of Delhi; the *Masjid* at Mandu in Malwa; the *Jami Masjid* at Bijapur; and the *Musalla*† a "small" *masjid* at Golconda.

Going into details, the "Taj Mahal" of Anglo-Indians is quite wrongly so called. *Taj* means a diadem, the comb of a cock, and *mahal*, an abode, a seraglio, a district, and *taj mahal*, a royal

* The word *masjid* means "place of prostration," *i.e.*, "of prayer," and in the mouth of the Spaniards became *mezquita*, and of the neighbouring French *mosquée*, and in English mouths, across the Channel, "mosk," and later "mosque."

† *Musalla* refers to the "small" mats, or carpets, used by Muslims as a "prie Dieu." The other terms for these small mats are *sajjahda*, meaning place of "prostration," and *jai namaz*, "place of prayer."

kingdom, a queen, etc. But here, as the European designation of the sepulchre of the dearly-beloved and loving Queen of the Mo(n)gol Emperor Shah Jahan, Argamand Banu Begum, it is simply the clipped and corrupted Anglo-Indian form of her imperial title of Mumtaz Mahal. As to the perplexed question of the "Taj Mahal" being a building, the consideration to bear in mind is that it is not a palace, nor place of habitation of any sort, but simply a *tabut*,* or "coffin" on its catafalqued bier, and "a tomb," a sepulchered—*i.e.*, an "honoured" tomb, and a Mausoleum, or magnificent "tomb," enclosing its two sarcophagi and two cenotaphs under one dome. Its type is to be found in the *taziahs* [literally, "consolations"], or model catafalques representing the tombs of Hasan and Husain at Karbela, carried by the Shiah Muslims of India and Persia in the solemnial procession of the Muharram. If this is kept in view, the airy, fairy lightness, and elegance, and sweet, and winsome grace of the "Taj Mahal," become, in my opinion, less inexplicable, if we must insist in penetrating into the magistery of its fascinations.

As to the cypress trees enshrouding it, I believe they were planted long after the date of Shah Jahan, and that the platform of the Taj was originally laid out with perennially flowering beds of the "African marigold." The complementary flush on the white marble building from them, under a clear blue sky, would have been a delicate terra-cotta pink; and may not that have been what Shah Jahan, or his sympathetic architect, precisely intended? The scarlet geraniums that now carpet the garden are in execrable "post-impressionist" taste, and must reflect a faint purplish grey from the building. I think there is true artistic insight in Mr. Havell's suggestion that any door that may have once been placed in the entrance to the Taj must have been of silver. But I cannot recall an actual closing door at the entrance to any Moslem *tabut* in India.

Of the more effective features of "The Taj" are its minarets, among the loveliest in all Islam; and the minaret is the one original feature the Saracens contributed to architecture; and it would be worth enquiring into its origins—in "the highest heaven of invention"! In spirituality of effect it equals the Christian spire; and both possibly originated in the instinct alike of Christendom and Islam to raise man up into the heaven of heavens, as opposed to the Heathen instinct—and I often feel the happier instinct—of bringing the high gods down into the common daily life of mankind. Then as to the concrete laid on the roof below the dome; it is a dreadful solecism; and I can hardly believe it to have been put there by Shah Jahan, or his inspired architect: and could it not be over flagged with Jeypore marble?

Lastly—of such details—I have always believed that the peaceful and consoling impression produced on its beholders by the "Taj Mahal," is not only due to the exceeding beauty and comeliness of its architecture, that at a glance satisfies your artistic sensibilities, and presents nothing to irritate and condemn, but in part also,—at least in the deep religious feeling it engenders,—to the touching associations of its conception, and the purpose it serves, as an everlasting memorial of the undying devotion of Shah Jahan and the Mumtaz Mahal to each other. Nothing outlasts to the end of the record of humanity but its pathos; and in all history there are no human instances more pathetic than the scene and circumstances of the death-bed of the great Akbar, and the love of Shah Jahan and the Mumtaz Mahal for one another, and his consummate commemoration of their ineffaceable affection. He was absolutely faithful to her for the twenty years of their unclouded and unsullied married life; she bore him the while nearly a score of children; and he remained faithful to her memory all the years he survived her; and the splendid and enchanting tomb wherein, to the awed awakening of the last trumpet, he sleeps beside her, took twenty years to complete and perfect to something of the measure of his measureless passion for her. That I believe to be the inmost secret in every manly and womanly heart of the enigmatic, incommunicable magic of the Mausoleum of the peerless Argamand Banu Begum, the Mumtaz Mahal, and her "blameless Polixenes," the magnificent minded Shah Jahan. Our unbounded thanks are due to Mr. Chisholm for the simple, lucid, and sympathetic manner in which he has demonstrated to us the fine artistry of the shrine that embalms both their fragrant hearts as in one and the same exquisite and enduring reliquary:—"An eternal [architectural] excellency, and a [spiritual and æsthetic] joy for evermore."

Sir STEUART COLVIN BAYLEY, G.C.S.I., said the only excuse he had for addressing the meeting was that he was an old friend of Mr. Chisholm. It was just about half a century ago that he first made the author's acquaintance at Patna, when he, being a Philistine, had not the least perception of the distinction and honourable position to which Mr. Chisholm would attain. They were both young in those days, and used to laugh—occasionally to laugh at their seniors—and although he would not say that Mr. Chisholm was irreverent, he had just that touch of irreverence which made for originality in an artist, and which enabled him to see for himself and teach others to see without consulting the books. That touch of originality could be seen not only in the paper but throughout all Mr. Chisholm's works on the Taj. He was not content with what others saw in the Taj. He must examine for himself, and having seen its glamour he must discover the secret of it, the character of its divergence from other Mogul architecture. What he (the speaker) thought the audience had to thank the author for most was the explanation he had given of the Taj. Hitherto they had always worshipped

* This is the same word as the Hebrew *tebah*, "ark," as applied (Exodus ii. 3) to Noah's Ark.

the Taj as an unknown god, but Mr. Chisholm had now given a reason for their faith. Up to the present time the Taj had always been spoken of as "A dream in marble"; Mr. Chisholm had shown that the dream came through the ivory gate. Shakespeare wrote that Queen Mab was the propounder of dreams. Evidently Mr. Chisholm had had Queen Mab to explain the Taj to him, and he had put that explanation into the paper. He (Sir Steuart Bayley) was sure he spoke for all present when he said, they were immensely indebted to Mr. Chisholm not only for the trouble and skill which he had taken in preparing the paper, but for enabling them to understand it.

On the motion of the CHAIRMAN, a vote of thanks was accorded to Mr. Chisholm, and the meeting terminated.

Mr. E. B. HAVELL writes:—Mr. Chisholm's paper raises so many points and contains so many ingenious suggestions that it is difficult to deal with it within a reasonable compass. I am glad, in the first place, that he has not attempted to revive the old Anglo-Indian legend that the Taj was designed by an Italian adventurer at Shah Jahan's court. That superstition takes a long time in dying, but some day, when it is decently buried, I hope we shall give it a monument in ferro-concrete as beautiful as that which Indian architects raised to Argamand Begum.

Mr. Chisholm seems to suffer from a conflict between his artistic feeling and his architectural conscience. As an artist he is constrained to admire the Taj with a whole heart; as an architect he is inclined to damn it with faint praise. I confess I am no more able to understand Mr. Chisholm's distinction between art and architecture than I can appreciate Sir George Birdwood's distinction between "fine" art and "decorative" art. The designer of the Taj was no doubt a great artist, but I cannot agree that he was lacking in architectural intelligence because he did not aim at producing the brilliant contrasts of ordinary architectural convention. The Taj was not an ordinary building with a utilitarian purpose; it was a monument to a beautiful woman and an architectural symbol of womanly beauty. All Mogul art, down to the time of Burangzih, was inspired by Hindu idealism, and I have not the least doubt that the designers of the Taj meant the main building to represent Argamand Begum herself, and the garden in which it was placed to be the Garden of Paradise, according to the beautiful symbolism often seen in Persian carpets and painting.

I fully agree with Mr. Chisholm that, in the present condition of the Taj and its surroundings, there is some jarring note which conflicts with the harmonious intention of the original plan, but I do not think that he has indicated the right way of resolving the discord. Looking at the section of the main building, and the limited area of the roof, it would be easy to prove mathematically that the substitution of the original marble for the present Portland cement would have no appreciable effect on the shadows of the domes, as seen from below; and, looking at the plan, I am at a loss to understand why Mr. Chisholm should think that the four smaller domes, or kiosks, surmounting the four small chambers, or chapels, at the angles of the building, and the four minarets at the corners of the platform, are not part of the original design. I fail to find the disharmony he points out, either in the smaller domes or in the minarets; probably Mr. Chisholm would not wish to be taken seriously in suggesting their removal. We might have an agitation started in India for the removal of the cupolas of St. Paul's Cathedral or the towers of York Minster.

The discord which exists at present is not, I think, to be found in any part of the building, but in the surroundings of it. The original formal garden, planned in accordance with Persian and Indian ideas, was an integral part of one great design, and when it was remodelled according to the ideas of an English landscape gardener, totally ignorant of Eastern symbolism, we seriously marred the artistic unity of the whole original conception, and produced a disharmony, or want of co-ordination in different parts of the architectural composition, by blocking out with great masses of heavy foliage different parts essentially related to one another. Recently an attempt has been made to improve the garden in this respect, but not, I think, with much success; in fact, the wrong alignment chosen for the cypress trees will, before many years, cause a serious disfigurement to the main view of the Taj itself, as I tried to show in an article I contributed to *House and Garden*, in April 1905. If we could conceive a formal garden on its original lines, as perfect in art and beautiful in symbolism as an old Persian carpet, spread out in front of the monument, we should still see the Taj Mahal as fair and flawless as its creators made it.

CANTOR LECTURES.

INDUSTRIAL PYROMETRY.

By CHARLES R. DARLING, A.R.C.Sc.I., F.I.C.

Lecture III.—Delivered December 5th, 1910.

RESISTANCE PYROMETERS.

When a wire composed of a single metal is heated, the resistance offered to the passage of a current of electricity is increased; and this augmentation of resistance continues as the temperature rises. Certain alloys, however, are practically unchanged in their resistance when heated; and some actually show a diminution, a property shared by carbon, which permits the electric current to pass more freely when hot than when cold. To demonstrate this point experimentally, we have

here a piece of iron wire coupled up with two cells and an ammeter, which measures the current passing through the circuit. On placing a burner beneath the wire, a large diminution in the current is indicated by the ammeter; but on removing the flame, and allowing the wire to cool, the current is restored to its former value. If, instead of iron, I use a piece of constantan (a copper-nickel alloy), heating makes little difference to the current; whilst with carbon the current is observed to increase. We thus gather that the greatest increase in resistance is manifested by pure metals, and this will guide us in applying the phenomenon to the measurement of high temperatures.

The first pyrometer based on this property of pure metals was devised by Sir W. Siemens in 1871. The metal used was platinum; and we may here note that all the exacting properties demanded of the metals used in a thermo-electric pyrometer for high temperatures, and fulfilled by platinum and allied metals, are in this instance of even greater importance. For, whereas the stretching of the wires, causing a diminution in diameter, would not affect a thermal junction, the resistance of the wire would be seriously altered, varying, as it does, inversely as the area of cross-section. The same remarks apply to thinning caused by oxidation or corrosion; and no good result can be secured unless the metal used remains completely unchanged in internal physical structure and external dimensions. No ordinary metal will fulfil these conditions above a red heat except platinum, which, chosen by Siemens, has remained ever since the only metal used in resistance pyrometers. In order to measure the resistance when in use, Siemens employed a device in which the current from a battery divided through a standard resistance and a voltameter on one side, and the pyrometer and another voltameter on the other. The current in each branch was determined from the quantity of gas liberated in the attached voltameter; and as the resistance in each section would vary inversely as the current, the resistance of the pyrometer could be determined. This method, although highly ingenious, was far too complicated ever to be welcomed in the workshop, and was replaced by a method of resistance measurement involving the use of a differential galvanometer. The principle of this method will be understood by reference to the diagram. A current from a battery B is divided into two branches, one containing the adjustable resistance R and one coil of the galvanometer, and the other the pyrometer P and the reverse coil. The galvanometer is wound so that both coils have an equal resistance, and with equal current exert the same pull on the magnet, but in opposite directions. When the current preponderates in one of the branches, the needle will move; but when equality is established in both circuits the needle will remain at rest. This condition is attained by adjusting R, and as equality of current in each half of the circuit indicates that each possesses the same resistance, R will then be equal to P. With the instrument thus made by Siemens, a table was provided from which the temperature could be read off; the value for known resistances given in the table having been determined by comparison with the gas scale. Some of these pyrometers are still in use.

The most concise method of measuring resistances, however, is furnished by the arrangement known as Wheatstone's bridge. In the diagram, B is a battery, G a sensitive galvanometer, *a* and *b* are fixed, known resistances, *d* is an adjustable resistance, and *x* the unknown. When *d* is varied until no deflection is shown by the galvanometer, the resistances in the four arms are so related that $\frac{a}{b} = \frac{x}{d}$, from which the value of x is readily obtained. When this method is applied to pyrometers, it is customary to make *a* equal to *b*, when *x*—in this case the pyrometer—has a resistance equal to *d*. This method of measurement was adopted in the later forms of Siemens' pyrometers, and is now generally employed by other makers.

The earlier form of Siemens' pyrometer consisted of a coil of platinum wound on porcelain, encased in an iron tube as a protection from the furnace gases. It was found, after a time, that the platinum had undergone a considerable change, the zero resistance rising 15 per cent. after repeated heating and cooling. This result was sufficient to discredit the method from an industrial standpoint, and for some years no further progress was made. Finally, however, the firm of Siemens and Co. largely overcame this difficulty by winding the platinum on a rod of special fireclay, and packing the space between the wire and the outer case with magnesia; the trouble having been caused, in the main, by furnace gases which penetrated the hot iron sheath and altered the physical character of the platinum so as to affect its resistance; which alteration is prevented by the presence of the magnesia. The Siemens resistance pyrometer is still made in this form.

The present success of the resistance pyrometer, however, is largely due to the researches of Callendar and Griffiths, who proved that under proper conditions the instrument could be made to give concordant readings, and was susceptible of a far greater degree of accuracy than the thermo-electric method. By careful comparison with the gas scale, these observers proved that the relation between the resistance of platinum and its temperature could be expressed by a formula which, over a wide range, would not lead to a greater error than $\frac{1}{10}°$ C.

Before proceeding to discuss this formula and its application, we will consider the possibilities of the resistance method with respect to the limits of accuracy. It is found, by experiment, that a piece of platinum wire which has a resistance of 2·6 ohms at 0° C., rises to the value 3·6 ohms at 100° C., an increase of 1 ohm. Assuming this increase to be uniform, the rise per degree is 0·01 ohm. Now this quantity is easily measured by the Wheatstone bridge method, using instruments that are suited to a workshop; hence a difference of 1° C. may be detected. With a larger battery power, and a more sensitive galvanometer, 0·001 ohm can be measured, corresponding, in the instance given, to a rise of $\frac{1}{10}°$ C. I illustrate this sensitiveness by accurately counterpoising on this electric balance—as Wheatstone's bridge is sometimes termed—a piece of platinum wire. When the spot of light is at rest the resistance is correctly adjusted; and now, by simply breathing on the wire, its resistance is sufficiently altered to send the spot of light flying along the scale. There is no single thermal junction which, when breathed upon, will give such a tangible result, and the great point in favour of the resistance method—that of greater delicacy—is thus conspicuously shown.

I have just made the assumption that the increase in the resistance of platinum is uniform, and that if we commence with 2·6 ohms every degree rise in temperature would add $\frac{1}{100}$ of an ohm. If this were correct, 4·6 ohms would correspond to 200° C.; 10·6 ohms to 800° C.; and so on. But when we test this matter by reference to our accepted standard, the gas scale, we find that the assumption is erroneous. We have been trusting the thin ice of extrapolation, and, as usual, the confidence has been misplaced. The work of Callendar and Griffiths, however, has shown that a definite relation exists between the values we have just assumed and the correct temperatures on the gas scale, so that by the aid of a formula the one may be converted into the other. If we indicate by p_t the degrees calculated on the assumption of uniform increase of resistance, and by t the true temperature on the gas scale, the relation between them is expressed by the formula

$$t - p_t = \delta \left\{ \left(\frac{t}{100} \right)^2 - \frac{t}{100} \right\},$$

where δ is a constant depending on the purity of the platinum, and generally has a value about 1·5. By inserting values in this formula, a table may be prepared from which the true temperature represented by the values calculated from resistance measurements may be read off. A few comparative numbers, calculated from this formula, are given in the table, the value of δ being 1·5:—

Temperatures calculated by assuming uniform increase of resistance.	True temperatures on gas scale (Deg. C.).
200	203·1
300	309·8
500	534·9
700	779·4
900	1049·4
1100	1355·0

It will be noticed that the difference between the readings increases rapidly as the temperature rises, and amounts to 255° at a true or gas scale temperature of 1355° C.

Having thus arrived at an accurate method of calibration, we may now proceed to examine the practical forms of instruments used at the present time. In the resistance pyrometers made by the Cambridge Scientific Instrument Company, the platinum wire is wound on a mica frame, and is connected by leads to a pair of terminals at the head. As these leads would alter in resistance on heating, a pair of exactly similar leads are also inserted, connected to another pair of terminals at the head, and are made to oppose the ordinary leads in the measuring arrangement, whereby the altering resistance of the pyrometer leads is rendered inoperative. The platinum is protected from furnace gases by surrounding the coil and leads with a porcelain tube. Fig. 9 shows a pyrometer of this pattern. In the Siemens resistance pyrometer, the wire is wound on a special fireclay and is preserved from damage by surrounding with magnesia and encasing in an iron tube, a single compensating lead being employed, joined up in the measuring device so as to cancel the variation in the ordinary leads. In America the Leeds-Northrup Company wind the platinum on lava instead of mica, and in

some cases use a differential galvanometer method to measure the resistance.

It is necessary, in industrial practice, that direct temperature readings on the gas scale should be obtained on the indicator, and in modern instruments this end is achieved in various ways. In the Siemens indicator an arm, moving round a dial, carries a tapping-key and on the edge of the dial is wound a wire resistance. The arm is moved round and the key tapped until no deflection is detected on the galvanometer mounted in the centre of the dial.

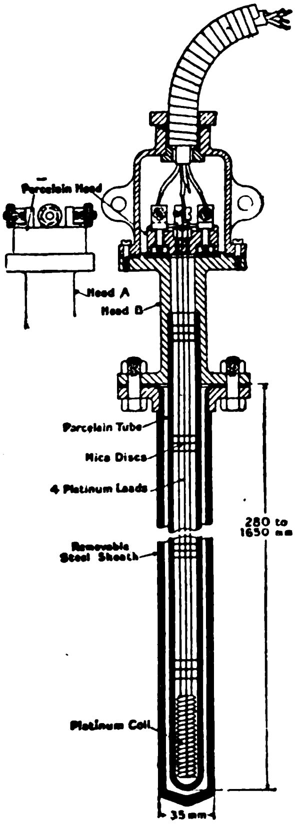

FIG. 9.—RESISTANCE PYROMETER.

(Made by the Cambridge Scientific Instrument Company.)

A pointer on the tapping-key then indicates the corresponding temperature by its position on the dial, and the measuring process is thus reduced to its simplest form. In Whipple's indicator, which also works on the Wheatstone bridge principle, the adjustable resistance is wound round a drum, and is operated by a handle connected to a screwed spindle which passes through a nut. Rotating the handle therefore imparts a spiral movement to the drum, and introduces a greater or less resistance in the arm of the bridge opposed to the pyrometer. A battery is brought into the circuit by the aid of a tapping-key, and the drum is turned until, on depressing the key, no deflection is noted on the galvanometer. The temperature may then be read off by noting the reading on a paper scale wound round the drum, a fixed pointer indicating the figure. The whole arrangement is contained in a single box for portability. These indicators are shown in Figs. 10 and 11.

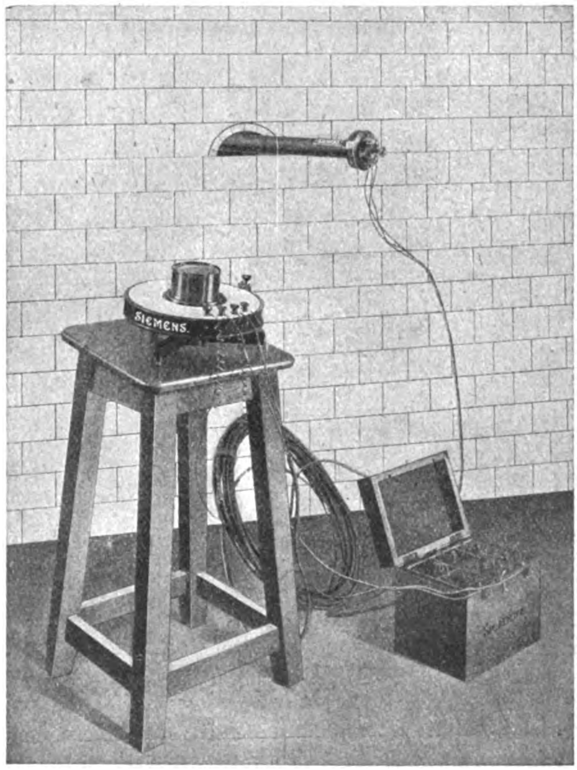

FIG. 10.—SIEMENS' RESISTANCE PYROMETER IN USE, WITH DIAL INDICATOR.

It will be observed that in both these indicators an experimental adjustment is necessary, which, although simple in character, takes up time and requires a moderate degree of intelligence to conduct properly. This drawback has not yet been completely overcome; but in the indicator made by Paul (Fig. 12), a series of step-resistances are provided, each representing an increase of 100° C. in the temperature of the pyrometer. The galvanometer scale is divided up so as to represent single degrees up to 100; and the procedure is to introduce the step-resistances until the pointer swings freely on

the scale, when the hundreds are read off from the steps and the units from the scale. In the latest form of this indicator the movement is electrically controlled, and is practically automatic. The Leeds-Northrup indicator works on the same principle, a voltmeter, however,

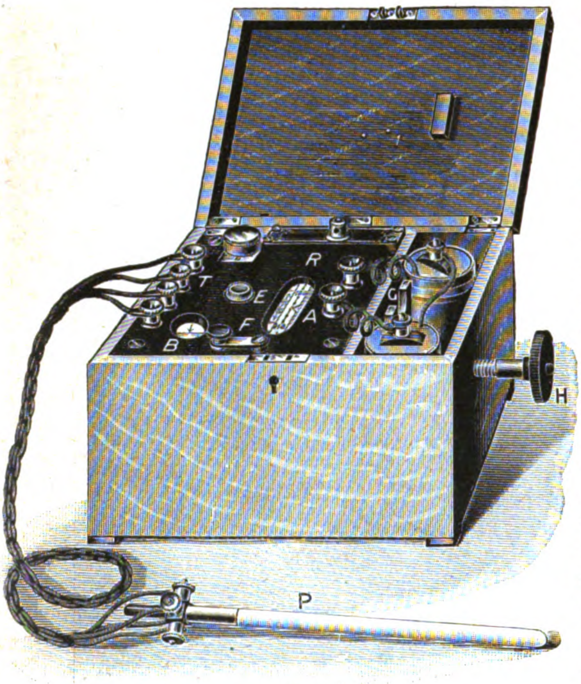

FIG. 11.—WHIPPLE'S INDICATOR.

replacing the more fragile galvanometer, and current from mains being employed to secure a sensitive indication, thus combining strength with accuracy. Both these instruments will indicate a fixed temperature without any manipulation, and in following a changing temperature it is only necessary to introduce another step as occasion requires. Both employ the differential method of resistance measurement.

We will now examine the possibilities of the finished instrument in industrial practice. The limit of temperature at which a resistance pyrometer may be continuously used is 1,000° C.; if this be exceeded for any length of time the resistance of the platinum is permanently altered, and the readings are thereby rendered erroneous. Below 1,000° C., however, it is possible to secure a more exact reading than can be obtained by the thermo-electric method; but this advantage is more apparent than real. In most cases it is not possible to control the temperature of a furnace to within less than 5° C.; and in such instances no advantage is secured by attempting to read to 1° C. Under special circumstances, where a high degree of accuracy is procurable and desirable, the resistance pyrometer is unrivalled for temperatures below 1,000° C. There are no errors to creep in analagous to those arising from alterations in the temperature of the cold junction of a thermo-electric pyrometer, and leads of any length may be used, provided the compensating leads are identical. On the other hand, the indications are not automatic, nor can the principle be easily applied to making an installation worked from a central office, owing to the difficulty of making each pyrometer of exactly equal resistance. In addition, the cost is greater than that of a thermo-electric outfit, and repairs are more difficult to execute. Hence the tendency is to employ the resistance pyrometer for very accurate work at moderately high temperatures, under conditions which demand a precision not to be obtained by the thermo-electric method. I show by the aid of slides several examples of the successful use of resistance pyrometers in the hot-air mains of blast-furnaces, biscuit-kilns for pottery, and annealing and tempering furnaces for the treatment of steel.

The first successful recorder for use with a resistance pyrometer was devised by Professor Callendar. In principle, this recorder (Fig. 13) consists of an arrangement by which the adjusting resistance in a Wheatstone bridge circuit is automatically made to equal that of the pyrometer by the movement of a slider over the

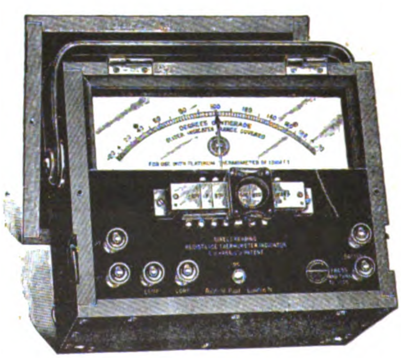

FIG. 12.—HARRIS'S INDICATOR.
(Made by R. W. Paul.)

resistance, a pen being carried by the sliding-piece which marks a graduated paper. The only part of a Wheatstone bridge circuit which

moves when the resistances are not adjusted is the galvanometer; and when the resistance introduced is greater than that being measured, the moving part of the galvanometer turns in one direction, and when less in the opposite direction. In Callendar's recorder a moving-coil galvanometer is used, and a boom attached to the coil is made to complete an electric circuit when the coil twists to the right, and another circuit when the coil turns to the left. The result in either case is to set in motion a mechanism which moves the slider along the resistance opposed to the pyrometer, the movement being to right or left according to the direction in which the galvanometer boom has moved, as the two mechanisms actuate the slider in opposite directions. When a balance is restored, the galvanometer boom will take up a central position, free of both contacts, and the sliding-piece will then be at rest. The paper in contact with the pen is wound on a drum, and made to rotate at a known rate by internal clockwork. If the slider carrying the pen remained at rest, a straight line would be traced on the paper, whilst movements due to fluctuations of temperature—and therefore of resistance—in the pyrometer will cause the pen to move to the right or left, thus drawing a sinuous line on the chart from which the temperature at any time may be deduced. Two slides are now shown to illustrate the utility of this recorder; in the first, the comparative merits of two stokers, who had instructions to keep a furnace at a given temperature, are clearly shown, together with the exact times when the furnace was neglected; and in the second slide we have a record of the heating and cooling of a piece of steel, on which the recalescence point is clearly shown, furnishing a guide to the subsequent treatment of the steel for the purpose intended.

It will be readily understood that the Callendar recorder contains, of necessity, mechanism of a delicate character, and requires careful handling. The galvanometer boom has to be relied upon to make a certain contact so as to complete the circuit which actuates the mechanisms; but the force with which the boom is pressed against the contact-surface is very small indeed, being due to the axial twist of the coil to which the boom is attached. Dr. Northrup, of Philadelphia, has recently designed a recorder in which this difficulty is overcome in the manner indicated in the diagram. The galvanometer boom G moves beneath two blocks of silver, A and B, separated by a thin strip of ivory. Beneath the boom is a silver block C, which is lifted by clockwork at stated intervals, so as to squeeze the boom between the upper and lower blocks. If the end of the boom be beneath A, the circuit E is completed, and actuates a mechanism which moves a pen along the adjusting resistance so as to restore the balance; if beneath B the circuit F is completed, and the pen moves in the opposite direction. If in a central position, as will be the case when the opposing resistance is equal to that of the pyrometer, the

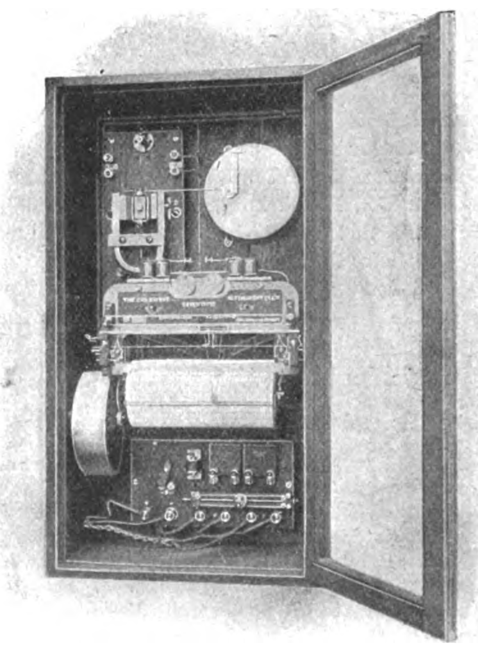

Fig. 13.—Callendar's Recorder.

boom will be pressed against the ivory, and neither circuit will be completed. In this recorder a differential galvanometer is used in preference to a Wheatstone bridge arrangement; but certain incidental difficulties remain to be overcome before the instrument is available for commercial use. Under the special conditions prevailing in a laboratory this recorder has already yielded excellent results.

In the hands of modern instrument makers, the resistance pyrometer, like the thermo-electric, has been converted from a crude and unreliable instrument to one of great utility

and accuracy. Yet all pyrometers which are kept permanently at high temperatures, and especially at any point above 1,000° C., undergo deterioration in the course of time. Even for occasional readings, when specially made for the purpose, the highest reading obtainable is the melting point of platinum, 1,753° C.—a temperature often exceeded in modern industrial operations. Evidently it would be an advantage if correct readings could be secured by means of an instrument, no part of which need be placed in the furnace, and which would be capable of measuring more exalted temperatures than is possible when pyrometers of the types previously described are used. Fortunately, modern scientific discoveries have enabled such instruments to be placed at our disposal, and they will form the subject of the fourth and concluding lecture.

[The following instruments were exhibited:—

Resistance pyrometers by Messrs. Siemens Bros. & Co., R. W. Paul, and the Cambridge Scientific Instrument Company, together with indicators for the same.

A Callendar recorder by the Cambridge Scientific Instrument Company.]

FIRST ANNUAL REPORT OF THE PORT OF LONDON.

The appearance of the first Annual Report of the new Port of London Authority is an event of more than ordinary interest. It was nearly eleven years ago that the increasing difficulties and complexities surrounding the ever-growing business of the Port brought home to the public with irresistible force and conviction the need of a general consolidated body or authority to overtake the functions properly attaching to a mass of well-defined duties and responsibilities. As is well known, a Royal Commission was the immediate outcome, and though enquiries of this character are sometimes unfairly criticised, it speaks well for this particular Commission that it conducted its investigations in a thoroughly business-like and practical spirit. In the short space of two years it had agreed upon a unanimous Report, which in its essentials was found to commend itself to the common-sense of Parliament and the public. Though the recommendations were naturally of a very voluminous character, involving as they did the transfer of great departments and undertakings from quasi-private hands to one public body, the initial requirement was, of course, the constitution of this central amalgamated authority.

The Port of London Authority consists of fewer members than originally contemplated by the Royal Commission. It comprises thirty members in all, the Chairman being Lord Devonport (formerly Sir Hudson E. Kearley, Bart.). Ten of these are "appointed" and nineteen "elected" members, but as a matter of practical convenience the elected members were appointed by the Board of Trade, after consultation with persons and bodies having knowledge and experience of trade or shipping in the Port. This was done in consequence of the inconvenience and delay that would have attended the preliminary organisation of the electoral machinery at the very outset of affairs.

One of the chief steps was the transfer of the undertakings of the three dock companies, viz., the London and India, Surrey Commercial, and Millwall Dock Companies, the stock of which constituted a total of £22,362,859, bearing interest amounting to £802,993 per annum. This new Port stock was officially quoted on the Stock Exchange on June 25th, 1909. Another undertaking transferred to the Authority was the Watermen's Company, whose incorporation dates back from 1827, and had actually originated in a guild dating from early in the sixteenth century. This company had for many generations exercised, under various Acts, the monopoly of the navigation of the river.

One important measure connected with the launching of the new Authority has been the enabling them to levy rates on river-borne goods entering London. This method of raising revenue for the purposes of the Port is, of course, an innovation in the case of London, being apparently framed on the precedent of Liverpool. To guard against its operating as an enhancement of prices, it is provided that the receipts from this impost must not exceed one-thousandth part of the aggregate value of the foreign goods imported and exported, or one three-thousandth part of goods imported or exported in vessels which do not go into any of the docks. The detailed schedule of rates was, under the authority of the Board of Trade, submitted to Lord St. Aldwyn, who held a public enquiry for the purpose of settling these rates on an equitable basis. A minor but important function of the Authority is concerned with the licensing or registration of craft, barges, boats and tugs, which hitherto, while enjoying exceptional privileges under what is known as "free-water conditions," have made but little, if any, contribution to the revenue of the Thames Conservancy or the dock undertakings. The estimated annual yield of these rates is about £13,000 per annum.

The total net tonnage of vessels that entered and cleared with cargoes and in ballast from and to foreign countries, British possessions and coastwise, at the Port of London during the year 1909, was 35,151,799 tons as compared with 33,768,599 tons during the year 1908.

The value of the total imports and exports

excluding coastwise goods) of the United Kingdom and the six principal ports was as follows:—

	1908.	1909.
U. Kingdom .	£1,049,681,008	£1,094,230,123
London . .	304,869,133	322,614,363
Liverpool . .	282,439,334	298,217,839
Hull . . .	61,555,005	66,672,983
Manchester .	40,403,763	43,508,069
Southampton.	38,157,776	42,116,457
Glasgow . .	41,695,383	41,238,867

Among the principal goods warehoused by the Authority are grain, timber, wool, frozen meat, tobacco, sugar, tea, wines, and spirits. The landings of grain for warehousing imported into London during the year ending March 31st last, showed an increase over those of the previous twelve months, the increase being mainly from Russia and Australia, the shipments from the United States and the Argentine showing a decrease. A large expansion is observable in the importations of Soya beans from Manchurian and Japanese ports. Timber showed an increase of about 180,000 tons, soft wood having risen while hard wood fell off, owing to shortage in the shipments of mahogany. Wool reached the Port in larger quantities, but there was a decrease in the number of bales sold in the London market, owing to larger sales having taken place in the Colonies, leading to direct shipments thence to the manufacturing districts. The frozen and chilled meat importations into London were 297,000 tons, of which about 45 per cent. was dealt with by the Authority. The whole of the tobacco warehoused in London is stored with the Authority, and the stock, on March 31st last, was 17,204 tons.

There is a vast amount of work in the way of developments and improvements which has been imposed upon the Authority by Parliament, and which will have to be carried out as soon as the new sources of revenue recently sanctioned are available. The evils complained of include insufficient depth of water in the docks, preventing the largest ships from using the Port, and causing loss and inconvenience by the detention of cargo to those frequenting it. Complaints are also rife of want of adequate dry-docking facilities, and of greater depth and width of the river channels to ensure freedom of ingress and egress to and from the docks, wharves, and discharging berths in the river. As for the dock properties and premises—these were generally found to be in want of proper repair, and to effect this will cost, so it is estimated, about £735,611. Of this a small proportion of £70,000 only has been put in hand, the remainder being reserved for future expenditure.

The maintenance of the river channels is essential to the existence of the Port. A navigable channel 1,000 ft. wide and 30 ft. deep at low water spring tides between Tilbury and the open sea was undertaken in 1907, and during the year ended March last, over two million cubic yards of material were raised. Progress is being made with the further deepening of the river to the same extent (30 ft.) as far as the Royal Albert Dock, and thence to London Bridge in gradually shallowing sections. For this purpose additional, and costly dredging plant will be required.

One of the most interesting incidents connected with the Authority is the grant to them by King Edward VII. of special armorial ensigns in which His late Majesty's own arms have been incorporated with those of King Edward II., in whose reign the Port of London was first opened. These ensigns have also been used for the purposes of the Common Seal of the Authority.

HOME INDUSTRIES.

Mining Accidents and the Eight Hours Act.—The Hulton Pit tragedy has served, among other things, to direct attention to the growing frequency of mining accidents. For fifty years the average mortality from accidents among our underground workers fell continuously. It fell from 5,149 to 1,411 per million persons employed underground, and the rate in the case of explosions fell from 1,280 in 1851-5 to 108 in 1896-1900. But during the last six or seven years the rate has been going up again, both as to accidents in general and explosions in particular. 1909 was the worst since 1896, the general rate having risen from 1,348 to 1,621; and the explosion rate from 20 to 272. In 1910 both rates showed further advance. What is the explanation of this very disquieting change? In his presidential address at the Scottish Miners' Federation, Mr. Snellie referred to the increase of accidents, which he described as very alarming, but ventured upon no explanation. The *Times* suggests that the last Workmen's Compensation Act has something to do with the increase in accidents. "It fosters carelessness, as the men are much less eager than they otherwise would be to avoid accidents in the first instance." But it is a rather far-fetched argument that the certainty of compensation leads to carelessness. Do men risk death more freely for being insured? Is the railway traveller who takes out an insurance ticket for the journey less anxious to avoid accident than his fellow-travellers? A much more plausible explanation is suggested by Mr. T. Good, who argues that the explanation is to be found in the Eight Hours Act. His contention is that this Act brings into existence "a whole combination of factors that add to the dangers of the miner's naturally dangerous occupation." It imposes uniform hours and conditions upon an industry in which both natural and economic circumstances vary widely between district and district, and even between mine and mine. And as with the pits and the business, so with the miners. The young man is able and willing to rush. The aged man is content to take his time. But the eight hours law treats all alike —"it sets nature, economics, and men alike at defiance." Under it "speeding up" will become a fine art in many mines. Already our miners are complaining that the owners are not only intro-

ducing dangerous new appliances and speeding up the work in every way possible, but that in order to maintain output they are employing additional hands who have not been used to mining and are thus a source of danger. And then the miners themselves, to counterbalance as far as possible the reduction of their earning time, pay less attention to bar-setting, propping, and other precautions. Moreover, the Act tends to oust the elderly workmen. The Act encourages mine-managers to get rid of their old men, who are slow, and employ vigorous young men in their place, and this means a gradual substitution of inexperienced and reckless men for experienced and cautious men. "The loss of the elderly pitman—the loss of his caution, watchfulness and advice will be an incalculable loss. The Eight Hours Act not only puts a big premium on speeding up, it places experience at a big discount." It may be objected that the Eight Hours Act cannot be wholly responsible for the increase in mining accidents, since that increase has been going on for six or seven years, and the Act was only passed in 1909, but it is a reasonable conclusion from the evidence that the Act has had a good deal to do with the acceleration.

Railway Accidents.—The terrible accident to the Midland Scotch express at Hawes Junction invites the enquiry whether more may not be done to lessen the chances of collision. It is impossible to eliminate the personal element. The most careful of men are liable to error, and error in a signal may mean, as at Hawes Junction, an appalling calamity. It is suggested—the suggestion is always made after a railway accident due to defective signalling—that there ought always to be two men in the signal-box, because both are not likely to forget the same thing at the same time. To that it is replied that two men have a divided responsibility, unless there is work for two and each attends to his own, and that if they have a divided responsibility, and there is really work for only one at any given moment, one may be doing the work and the other looking on, or not even doing that. The mischief is usually done in a few seconds, and who is going to guarantee, year in and year out, the alert attention of the second man? Such guarantee is impossible, but the objection is not conclusive. It may be possible to lessen risk, though not entirely to eliminate it. Many "boxes" are in isolated and lonely positions; any man is liable at any moment to lapse of memory or to illness, and the great responsibility of direct signalling ought not to be dependent upon the avoidance of human fallibility. But the best check upon human failure is to be found in automatic precautions, and it is not easy to see how such accidents as the one at Hawes Junction could occur if the "lock-and-block" system were general, for under this system it is practically impossible for two trains, or engines, to be on any of the sections into which the line is divided at the same time. These automatic devices deserve the most careful and constant study. For example, it is claimed for the Brown-Mackenzie system—no opinion is expressed here as to the validity of the claim—that the Hawes Junction disaster would have been impossible had this system been in use on the line. The prime object of the inventors is to provide a system which can be used as the sole means of signalling on a railway, the indications being given in the engine-cab instead of on the wayside. With this object in view, the track equipment is arranged in such a way as to cause the trains themselves automatically to operate the signals. The method employed embodies the main principles of lock-and-block, but greater freedom in dealing with the traffic is said to be possible than with any previous application of the lock-and-block. The system may, however, be used as an auxiliary to any existing system of semaphore signalling (either automatically or manually controlled), in which case it may be controlled automatically and independently from the other system, or it may act simply as a signal repeater, giving the repeated signal in the cab of the engine.

Shipping and Managing Owners.—The managing owners of ships are largely responsible for the excessive amount of British tonnage in existence. The capable and energetic man who becomes a managing owner—the phrase used to be "a ship's husband"—is not restricted by those prudential considerations which in the past were obstacles in the way of excessive construction. His title is a misnomer. His personal stake in the ship is generally small. He is the agent of such of the owners of a ship as appoint him, and part owners are of all positions and both sexes. If he wishes to build a steamer, and can obtain a small proportion of the capital necessary to build and fit out a vessel, he can always find a builder who will allow a large part of the cost of construction to remain on mortgage. And he is paid by commission on the gross freight, a practice which—as a correspondent of the commercial supplement of the *Times* points out in an interesting communication—though excellent from his point of view, is fraught with evil. The system of payment by commission ensures the managing owner some remuneration, whether or not the actual owners obtain dividends. If, in a year or two the builders, or other mortgagees who have enabled the vessel to be built and equipped, take possession under their mortgage, the managing owner has for a time reaped a benefit from his speculation, though the whole capital of those who have invested in the ship may be lost. If, on the other hand, the vessel turns out to be a success, he is certain of a satisfactory return for some years, and of an increase of business reputation. In the opinion of the writer in the *Times*, the question will sooner or later have to be answered (in view of the large amount of shipping which is still unprofitable) whether the term "managing owner," which was inserted in the Shipping Acts for a definite non-commercial purpose, may not have to be regarded from a wider point of view. It may

be necessary, in consequence of the tendencies and progress of modern shipping, that every person who manages a vessel shall have an actual and substantial interest in her. And this seems the more reasonable, since the managing owner is in the habit of insisting that the master of a vessel shall invest a substantial sum in her, a condition that may well operate against the public interest, inasmuch as it tends to inefficient command. An old and incapable sailor who can put some money into a ship is often preferred by the managing owner to a younger and better seaman who cannot do so.

The Cotton Industry.—The year just ended was a bad one for the cotton industry, bad for employers and bad for operatives. The capital invested in spinning and weaving concerns has not been remunerative, and the workpeople have not been fully employed. The bottom of the trouble was the high prices in raw cotton. The year opened with Middling American cotton on the spot in Liverpool quoted at 8·44*d*., and the quotation at the end of the year was 8·12*d*., the lowest price in the intervening period being 7·56*d*., the quotation on January 21st. In Egyptian cotton, prices were on a higher level at the beginning of the year, Fully Good Fair Brown being quoted at 13¾*d*. At the end of March the quotation had risen to $16\frac{3}{16}d.$, but at the close of December it had fallen to $11\frac{1}{16}d.$ As to the future, the outlook is not encouraging so far as America is concerned, where the crop is estimated at 11,600,000 bales. In Egypt, the official estimate of the Alexandria General Produce Association is 7,000,000 cantars. From India the reports are not so favourable. The big Egyptian crop will to some extent make up for the smaller supply in the American staple, but it seems certain that the raw cotton supplies of the year will not be sufficient to prevent some shortage, and high prices must be expected. Users of Egyptian cotton did better last year than spinners of American yarn, but a good deal of money was lost in both departments. Statistics just issued show that the loss on share capital for the twelve months ended November 30th was over 10 per cent. It has been the worst year for shareholders since the limited liability company came into existence.

OBITUARY.

P. K. Rajam Ayar.—Intimation has just been received of the death of Mr. P. K. Rajam Ayar, which took place on October 4th, 1910, at the age of 52. Mr. Rajam Ayar was for upwards of ten years Tahsildar of Trichinopoly, and was about to retire from the public service. He was keenly interested in archæology. He became a life member of the Royal Society of Arts in 1900.

NOTES ON BOOKS.

Studies in the Decorative Art of Japan. By Sir Francis Piggott. London: B. T. Batsford. 25*s*. net.

This work is quite evidently a labour of love. The Nikko and Shiba temples have been well-loved haunts of Sir Francis Piggott, and his interest in tracing the evolution of symbolic diapers and borders is keen and sustained. The studies are rather loosely strung together, but the author has much to tell that is interesting, and the separate papers are fairly complete, whilst the illustrations, both in black and white and in colour, are well worth studying.

There is, perhaps, not very much to be said about the early part of the volume, which deals with Temple Decoration and is divided up under the headings of "The Decoration of Flat Surfaces," "Wave and Cloud Forms," and "Lattice Work," except that the author is dealing with an interesting and little known subject in a deeply sympathetic spirit.

The paper on "The Use of the Circular Form" is one which should appeal strongly to designers, and to teachers of design, as it explains very fully the method of sub-dividing the circle adopted by the Japanese, and gives many examples of their power of successfully conforming what appear to us the most rigid and unbending forms to a circular shape.

The long paper on "The Pakwa Diapers and Keyborders of the East," which closes the volume, and which includes, by the way, a discussion of the origin of the *Svastika*, is the only controversial part of the book. The origin of the key pattern has been so hotly disputed that agreement between the advocates of different theories seems too much to hope for, but Sir Francis Piggott certainly makes out a very ingenious case for the border having been derived from an all-over *Pakwa* diaper —and he proves quite conclusively that it could have been evolved from *Pakwa* elements. Whether it necessarily was so derived is rather a different question, and one which will probably receive different answers according to the bias of the people interrogated. The antiquarian will probably always look for its origin in some particular country, whilst the designer is more inclined to regard it as a form of decoration which might quite well have been evolved independently in a number of different places, as the outcome of a desire for simple decoration and the habit of working with simple tools or appliances.

Educational Aims and Efforts. By Sir Philip Magnus, M.P. London: Longmans, Green and Co., 1910.

For the past thirty years Sir Philip Magnus has been closely associated with the progress of technical education in this country, and the book which he has just published is a record of much

valuable educational work. The greater part of it is a reprint of the various addresses which the author has given on educational subjects, and these alone show the progress which has been made, and the change of view which has taken place (much of which change, indeed, is due to Sir Philip's own labours) during the past five-and-twenty years. Besides this, there is an introductory chapter, the most interesting portion of which is, perhaps, Sir Philip's account of the early history of the City and Guilds of London Institute, of which he was appointed organising director and secretary in 1880.

Sir Philip commences his narrative with his own appointment. But a good deal of useful work had already been done, and it would have added to the interest of this chapter of the book if some account of the early origin of this important association had not been omitted.

It should also be mentioned that much of Sir Philip Magnus's useful work in connection with the University of London finds a record here, and this goes back even to an earlier period than 1880, the date at which the book professes to commence.

GENERAL NOTES.

Bulgaria and British Trade.—In his report on Bulgaria just issued (No. 4,609 Annual Series), the Hon. F. O. Lindley, Secretary to His Majesty's Legation at Sofia, is able to report that in the quinquennial period 1905-9, British exports to Bulgaria increased, but this increase was not very considerable, and Mr. Lindley hints at some of the reasons. He reminds merchants that commercial travellers with a knowledge of foreign languages are the best means of obtaining business in foreign countries; that few people in Bulgaria understand English, and that still fewer comprehend either English money values or English weights and measures; that catalogues, therefore, to be of any use, should be drawn up either in Bulgarian, or in French or German, with values in francs or marks, and, above all, with metric weights and measures, which are those in use in Bulgaria; finally, that other things being nearly equal, the merchant who gives credit obtains the order. With regard to this latter point, Mr. Lindley does not suggest that merchants should give indiscriminate credit; such a course would be quite as disastrous to them in Bulgaria as it has proved recently to some of their rivals in North China. But a good deal of business is lost in Bulgaria owing to a rigid insistence on cash against documents, and it is possible to give a certain amount of accommodation, if very careful enquiries are made as to the standing of the persons dealt with. In this connection it may be mentioned that there is still no British bank represented in Bulgaria, although for years one has been talked of. Such an establishment could hardly fail to promote British commercial interests, and Mr. Lindley thinks it would also prove remunerative from a purely banking point of view.

Swiss Watches.—The value of the watches exported from Switzerland in 1909 fell by about 20 per cent. as compared with the figures for the preceding year, but the number of watches exported increased by 332,500. The prices of watches with cases of nickel or other common metals fell to a very low figure, while those for silver watches again slightly receded. On the other hand, the average price obtained for gold watches was higher than at any time during the last ten years. Some figures quoted by Mr. Vice Consul Milligan, in his report upon the trade of Switzerland just issued (No. 4610 Annual Series), show a rather surprising distribution of Swiss watches exported. Germany took 294,551 gold watches as against 133,470 that came to the United Kingdom, and 691,878 silver watches as against 258,320 imported by this country; but of nickel watches Germany took only 444,411 as compared with 1,379,745 that came to Great Britain. One would have thought that the cheaper article would have been more in demand in Germany. The Swiss manufacturers are much concerned at the foreign competition, which is seriously affecting the Swiss watch industry, and the official report upon the industry directs the attention of Swiss manufacturers to the national danger in supplying foreign manufacturers with detached parts of watches.

Argentine Centennial Exhibitions, 1910.—In the General List of Awards at the Argentine Railway and Land Transport Exhibition, Great Britain easily secured the first place with 222 awards, her nearest competitors being Germany with 171 awards, Italy with 155, France with 122, and the United States of America with 72 awards. These totals are made up as follows: Great Britain, 82 grands prix, 12 diplomas of honour, 75 gold medals, 39 silver medals, and 12 bronze medals; Germany, 70 grands prix, 35 diplomas of honour, 41 gold medals, and 18 silver medals; Italy, 70 grands prix, 35 diplomas of honour, 40 gold medals, and 5 silver medals; France, 64 grands prix, 25 diplomas of honour, 25 gold medals, and 4 silver medals; and the United States, 21 grands prix, 8 diplomas of honour, 33 gold medals, and 6 silver medals.

Chinese Machine-made Embroidery. — The adaptation of an ordinary sewing machine to the making of silk embroidery has been taken up by the Chinese in Hong-Kong, and in other places in South China, with considerable enthusiasm, and although the idea was put into execution only a little over one year ago, the progress made in producing really handsome machine work is notable. It is the Chinese ladies of the better class who are learning to make embroidery, and in Canton, for

instance, some of the more wealthy ladies have organised classes in their respective residences in order to study the art further, for it is not simply a matter of the machine doing all that is required, but much scope is left for the individual in designing as well as colour shading. The work is done chiefly on Chinese raw silk (at the beginning Japanese was used), and comprises all kinds of designs—scenery, bird life, flower studies, emblematical scrolls, etc. The only foreign substance that enters into the work is the bobbin thread of cotton. No restrictions are placed on the designs, and the varieties of embroideries made show exquisite taste, and likewise excellent judgment is displayed in the grouping of the colours. In Hong-Kong there are about thirty young Chinese women who are learning the art, the majority doing this purely as a pleasant pastime, and this method of producing beautiful work of uniform quality seems to appeal strongly to them. There are three teachers—an artist to teach drawing, designing, and colour-shading, an instructress in the actual embroidery work, and an instructor in the use of the machine.

THE PRODUCTION OF GUM TRAGACANTH.—The yield of gum tragacanth for 1910 is said to be about one hundred and forty tons as compared with about two hundred tons in 1909. This gum is the product of a plant growing wild in the mountainous region of Cappadocia, Asia Minor. The plant is a small bush which grows only at an altitude of 4,500 to 7,500 feet, and is most plentiful on the slopes of Mount Argæus, 12,560 feet high, of the Taurus Range near Cæsarea. In June the earth is scraped away from the base of the stem of the plant and incisions are made near the root. The sap, which gradually oozes out, hardens into spiral formations. The first exudations are whitish, and these are the most desirable, especially in the American market. As the earth which has been scraped away lies loose about the plant, should any rain fall while the gum is forming it will wash the loose soil upon the exuding sap, and thereby discolour the resulting gum. This was especially true in 1910, and hence the yield is inferior both in quality and in quantity. As a matter of fact it is mostly discoloured. The prices were higher in 1910 than in 1909, and the prospects are that with a steady demand they will be still higher. Cæsarea is the principal market for tragacanth gum, but it is mostly transported by camels to Mersina, whence it is shipped to Europe and America. In 1909 the total exports were valued at £28,000. The gum is employed in the arts, and by druggists in the preparation of lozenges and emulsions, to hold the basic element in suspense.

REINFORCED-CONCRETE SLEEPERS AND FENCING POSTS.—About a quarter of a mile of the London and North-Western Railway Company's "up" line immediately north of Pinner Station has been laid with sleepers formed of reinforced-concrete. These sleepers are placed somewhat closer together than those made of timber, and except where the chairs are placed they are of smaller section. It is understood that if the experiment shows satisfactory results, the use of concrete for the purpose will be extended. The company have already had steel sleepers under trial, but the experience gained with them was not encouraging, as it was found that they tended to make the track far more noisy when under traffic. According to the *Timber News*, reinforced-concrete is now being also adapted for fencing posts of various descriptions. With regard to the cost, it is stated that in one instance a railway fence has been erected complete at about 1*s.* 8*d.* a yard, and that in many places cement, sand, and iron, can be obtained and made into posts at a price less than that of deal. It is suggested that the life of these posts should be very long, say one hundred years, whereas that of deal untreated with preservative is only about ten years, or, if creosoted, about twenty. Among railway companies, the London and North-Western, the Great Northern, and the Great Eastern, have erected fence posts of this description.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

JANUARY 18.—JOHN C. MEDD, M.A., "The Dutch Labour Colonies." LORD REAY, G.C.S.I., G C.I.E., will preside.

JANUARY 25.—HORACE M. WYATT, "Motor Transport in Great Britain and the Colonies."

FEBRUARY 1.—PHILIP JOSEPH HARTOG, M.A., B.Sc., "Examinations and their bearing on National Efficiency." The EARL OF CROMER, G.C.B., O.M., G C.M.G., K.C.S.I., C.I.E., Vice-President of the Society, will preside.

FEBRUARY 8.—Captain A. J. N. TREMEARNE, B.A., D.Anth., "Some Nigerian Head-Hunters."

FEBRUARY 15.—GEORGE A. STEPHEN, "Modern Machine Book-binding." JOHN MURRAY, J.P., D.L., F.S.A., will preside.

FEBRUARY 22.—Professor J. WERTHEIMER, B.Sc., B.A., "Water-Finders."

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

JANUARY 19.—REGINALD MURRAY, "Banking in India." Sir FELIX SCHUSTER, Bart., will preside.

FEBRUARY 9.—R. A. LESLIE MOORE, I.C.S. (retd.), "Indian Superstitions."

March 16, April 27, May 25.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

JANUARY 31.—F. DOUGLAS OSBORNE, M.Inst.M.M., "The Tin Resources of the Empire."

FEBRUARY 28.—The HON. SIR RICHARD SOLOMON, K.C.B., K.C.M.G., K.C.V.O., K.C., M.A., High Commissioner for the Union of South Africa, "The Resources and Problems of the Union of South Africa."

APRIL 4.—Captain R. MUIRHEAD COLLINS, C.M.G., "Australia and her Resources."

MAY 9.—F. WILLIAMS TAYLOR, "Canadian Banking."

CANTOR LECTURES.

Monday Evenings, at 8 o'clock:—

FREDERICK WEDMORE, "Etching." Two Lectures.

LECTURE I.—JANUARY 23.—"The Old Masters." The Cradle of great Etching—Rembrandt's place—Ostade and Bega—Vandyke—Landscape and Animal Subjects in the Low Countries—The Classic Landscape—Claude—Links with the Moderns—Etching no "Minor Art."

LECTURE II.—JANUARY 30.—"Modern Etching." Goya—Wilkie and Geddes—The Silence before the Revival—The great French Outburst—Méryon, Bracquemond and Jacquemart—Haden and Whistler—Themes mainly Landscape, Portraiture, Architecture—The Etching of To-day.

Professor ADRIAN J. BROWN, M.Sc., "Brewing." Four Lectures.
February 6, 13, 20, 27.

Professor J. A. FLEMING, M.A., D.Sc., F.R.S., "Applications of Electric Heating." Four Lectures.
March 6, 13, 20, 27.

ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.
May 1, 8, 15, 22.

Dates to be hereafter announced:—

FRANK M. ANDREWS, "Architecture in America."

ARTHUR CHARLES DAVIS, F.C.S., Assoc.Inst.C.E., "The Manufacture and Testing of Portland Cement."

GEORGE B. HEMING, "Art Education in Jewellery and Goldsmithing."

Colonel CHARLES EDWARD CASSAL, V.D., F.I.C., "The Adulteration of Food."

Dr. LEONARD HILL, F.R.S., "Caisson Sickness and Compressed Air."

Sir WILLIAM ABNEY, K.C.B., D.C.L., D.Sc., F.R.S., "The Quantitative Measurement of Colour-Blindness."

HAL WILLIAMS, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

NOEL HEATON, B.Sc., F.C.S., "The Production and Identification of Artificial Gems."

Sir THOMAS HENRY HOLLAND, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India." LORD AVEBURY, D.C.L., LL.D., F.R.S., will preside. (Indian Section.)

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 9...Brewing, Institute of (London Section), Criterion Restaurant, Piccadilly, W., 8 p.m. Mr. Otto C. Overbeck, "The Production of Alcohol in Beer without Fermentation."

Victoria Institute, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Rev. J. J. B. Coles, "Theosophy."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. E. H. Blake, "Notes on Highway Law as affecting Property Owners."

Geographical, in the Theatre, Burlington-gardens, W., 3 p.m. (Juvenile Lecture.) Dr. Vaughan Cornish, "Scenes and People in Jamaica."

Engineers, Cleveland Institute of, Corporation-road, Middlesbro', 7.30 p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Professor E. Gardner, "Art as Expression and as Illustration."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. H. H. Statham, "Architecture as Plan and Section."

TUESDAY, JANUARY 10...Asiatic, 22, Albemarle-street, W., 4 p.m. Dr. M. Gaster, "Turkish History from Jewish Manuscripts."

Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Professor S. P. Thompson, "Sound: Musical and Non-Musical. Lecture VI. —Reproduction of Sound."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. William Dawson, "The Strengthening of the Roof of New Street Station, Birmingham," and "The Reconstruction and Widening of Arpley Bridge, Warrington."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. F. Martin-Duncan, "Application of Photography to Biology."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. Sir Daniel Morris, "The Imperial Department of Agriculture in the West Indies."

WEDNESDAY, JANUARY 11...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. (Juvenile Lecture.) Professor A. M. Worthington, "A Study of Splashes, Conducted by the aid of Instantaneous Photography." (Lecture II.)

Biblical Archæology, 37, Great Russell-street, W.C., 4.30 p.m. Paper on "The Tombs of the Kings at Jerusalem."

Geological, Burlington House, W., 8 p.m.

Automobile Engineers, at the Institution of Mechanical Engineers, Storey's Gate, S.W., 8 p.m. Mr. F. R. S. Bircham, "The Development of Engines for Marine Purposes."

THURSDAY, JANUARY 12...Cyclists' Touring Club (Metropolitan District Association), at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8.30 p.m. Mr. E. C. Russell, "With the M.D.A."

Architects, Society of, 28, Bedford-sq., W.C., 8 p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. D. G. Hogarth, "Cretan Discoveries."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. W. Bickerton, "Wild Birds and their Ways."

Electrical Engineers, Victoria Embankment, W.C., 8 p.m. Discussion on paper by Major W. A. O'Meara, "Submarine Cables for Long Distance Telephone Circuits."

Engineers, Junior Institution of, at the United Service Institution, Whitehall, S.W., 7.30 p.m. Mr. H. F. Donaldson, "Depreciation of Buildings and Machinery."

FRIDAY, JANUARY 13...Royal Drawing Society, in the Art Gallery, Guildhall, E.C., 4.30 p.m. 1. Annual General Meeting. 2. Mr. T. R. Ablett, "A Method of Developing Visualisation."

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FRIDAY, JANUARY 13, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 18th, 8 p.m. (Ordinary Meeting.) JOHN C. MEDD, M.A., "The Dutch Labour Colonies." Lord REAY, G.C.S.I., G.C.I.E., will preside.

THURSDAY, JANUARY 19th, 4.30 p.m. (Indian Section.) REGINALD MURRAY, "Banking in India." Sir FELIX SCHUSTER, Bart., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

COVERS FOR JOURNALS.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1*s*. 6*d*. each, on application to the Secretary.

JUVENILE LECTURES.

On Wednesday afternoon, January 11th, Mr. ARTHUR MASON WORTHINGTON, C.B., M.A., F.R.S., late Professor of Physics in the Royal Naval College, Greenwich, delivered the second and final lecture of his course addressed to a juvenile audience on "A Study of Splashes, conducted by the aid of Instantaneous Photography."

The lecturer began by referring to a question which had been put to him by one of his audience at the close of his previous lecture: "When a bubble is formed what becomes of the ascending central column previously seen?" The answer depends on the completeness and firmness with which the bubble is closed. Photographs showed in a very beautiful manner how, with a rather lower height of fall, the bubble reopened immediately and made way for an emergent column bearing the original drop on its summit. At other times the rising column forced its way through the bubble, causing a temporary irregularity which, however, was soon smoothed away under the influence of the surface tension.

The splashes of solid spheres were then examined. Well-polished marbles were dropped into a deep glass bowl full of water, and the audience could see that they slipped in noiselessly with hardly any visible splash. The same spheres if wet, or roughened with sandpaper, or even if dusty, made a great noisy, bubbly splash accompanied by the projection into the air of a tall jet of water whose summit rose even higher than the place from which the marble fell. In order to explain this astonishing difference, each kind of splash was then followed in detail by means of the instantaneous photographs, which showed what happened both above and below the surface.

With the rough sphere the crater thrown up was curiously like that accompanying the splash of a liquid drop, and can be described as a "basket" splash. The sphere in this case enters the liquid without really breaking the skin, which is drawn into a surprisingly deep cylindrical pocket containing air. This ultimately divides into two parts, the lower part constituting a bubble which is attached to the sphere and follows in its wake to the bottom of the containing vessel, when it becomes detached. Then, and only then, does the upper part of the sphere, hitherto perfectly dry though far below the surface, come into contact with the liquid. Meanwhile, the upper part of the air-column forms a deep, hollow basin, into which the liquid flows from all sides. The converging streams, which gain velocity as the channel narrows towards the centre, there meet, and, spirting upwards, form the ascending column.

With a smooth sphere, on the other hand, the splash is totally different from the very first instant of contact. For the liquid, instead of being driven laterally away, is retained by

the force of adhesion, and guided over the solid surface so as to envelope it in a liquid sheath of exquisite thinness: thus the sphere becomes covered with liquid before it is even below the general level of the surface. One very instructive photograph, obtained originally by accident, showed how a sphere polished on one side, and rough, or dusty on the other, produced simultaneously the two kinds of splash—the "basket splash" and the "sheath splash." The effect of increasing the height of fall of a rough sphere to anything from 5 to 25 feet was then examined. As the audience had already seen, the tall, rebounding column now disappeared, but the photographs revealed a very astonishing new phenomenon—namely, the formation of an interior jet of liquid following the sphere downwards through the middle of the long air column. [It is impossible to give any clear idea of the origin and appearance of this phenomenon without reproducing the photographs themselves.] It was shown that the final condition reached was that of a double vortex-ring, one accompanying the sphere and one remaining at the surface.

In conclusion, Professor Worthington showed to the audience the under-water air-column of a "basket splash" just in the act of dividing, projected on the screen by means of an electric flash produced at the right instant.

On the motion of the Chairman, a vote of thanks was accorded to the lecturer for his interesting course.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

INDUSTRIAL PYROMETRY.

By Charles R. Darling, A.R.C.Sc.I., F.I.C.

Lecture IV.—Delivered December 12th, 1910.

Radiation Pyrometers.

It was remarked in the first lecture that Newton, in 1701, made an attempt to measure the temperature of a coal fire by a method depending upon the rate at which an iron bar, drawn from the fire, radiated energy to its surroundings. In the last century many observers, taking advantage of Nobili's thermopile, endeavoured to determine a relation between the energy falling on the thermopile and the temperature of the radiating source. Amongst those who worked in this direction was Tyndall, who recorded a number of results obtained by allowing the radiations from a platinum surface, heated to different temperatures, to fall on a thermopile, the deflection of the needle of the galvanometer in the circuit being noted for each temperature. These figures lay in the pigeon-holes of science for many years; but in 1879 Stefan of Vienna, on submitting them to a close examination, came to the conclusion that the energy radiated by the hot platinum varied as the fourth power of the absolute temperature. Stefan expressed the opinion that all solid bodies radiated energy according to this law, under certain attainable conditions of surface—a conclusion which has proved to be erroneous. It would be well at this stage briefly to consider the ordinary manifestations of radiant energy in this relation. Every substance, provided its temperature be above absolute zero, radiates energy by the medium of ether waves, and when the various objects in a room attain an equal temperature, each is radiating to its surroundings an amount of energy equal to that which it receives. The nature of the surface of a solid, however, plays an important part in connection with the quantity of radiant energy emitted or absorbed under given conditions. To illustrate this point I place a strip of platinum foil in front of a thermopile, and heat it to redness by means of a current of electricity. One face of the foil is bright, and the other coated with a dark oxide; and on presenting the bright side to the thermopile we obtain a deflection of the spot of light from the galvanometer to which the pile is connected. I now rotate the platinum strip so that the dark side is opposite the thermopile, when we observe that the deflection increases considerably, although the temperature has not altered. Evidently, therefore, it is necessary, in considering any radiation laws, to take the nature of the surface of the radiating body into account. Of all the surfaces examined, a dull black, such as soot or lampblack, is found to be the best both for radiating energy or for absorbing radiations which fall upon it; but even this surface is not perfect. A perfect surface, from the radiation standpoint, would absorb all radiations incident upon it, and none would be reflected or transmitted through it.

We may now return to Stefan's interpretation of Tyndall's results. In the year 1884 Boltzmann published a mathematical investigation of the subject, based on thermodynamic reasoning, and arrived at the same result as Stefan, namely, that the energy radiated by a hot substance

varied as the fourth power of the absolute temperature, provided — and herein lay the clarifying effect of Boltzmann's investigation—that the surface behaved as a perfect radiator of energy. I do not propose to-night to give the details of this valuable contribution to scientific knowledge; suffice it to say that two assumptions made in the investigation, viz., the existence of light pressure, and of the composition of the spectrum of radiation when changing in density, were afterwards proved to be justifiable by Lebedew and Wein. We are, therefore, not dealing with an empirical law, but with one capable of mathematical proof; and we may therefore apply this law with confidence in all cases where the condition of perfect radiation is realised.

If, however, no known surface acts as a perfect radiator, the question at once arises:—How is it possible to apply the fourth-power law in practice so as to measure temperatures? To answer this we must refer to the work of Kirchoff, who in 1860 pointed out that an enclosure, at a constant temperature throughout, would emit radiations through a small aperture in one side to exactly the same extent as would a perfect surface at the same temperature. Such an arrangement was termed by Kirchoff a "black body"—not that it is necessarily black in colour, but because it conforms to our ideas of absolute blackness in the sense of total absorption of radiations. As this conception of a "black body" has a most important bearing upon practical pyrometry, we will consider it a little more closely. If radiations enter an enclosure with opaque walls, they are evidently trapped in, and absorbed as totally as if they fell upon a perfectly-absorbing surface. To show that radiations leaving the enclosure through the opening are also equivalent to those emanating from a perfect surface, we may consider a spot on the wall opposite to the aperture. Rays leaving that spot will be partly reflected, and partly radiated; but if the temperature be constant the amount leaving the spot will be equal to the amount received from the enclosure. Hence the rays passing out from the spot will be equal in amount, whatever the character of the surface, which, if perfect, would radiate all the energy; and which, if imperfect, would radiate some and contribute the balance by reflecting directly those rays which are not absorbed.

Now the value of all this in relation to pyrometry arises from the fact that almost all operations at high temperatures are conducted in enclosures which we call furnaces, and radiations from the interior of a furnace through a small opening in the side are true black-body radiations. Thus it fortunately happens that the very condition necessary to render the fourth-power law valid in practice is realised in almost all our industrial processes. There is also a simple method of obtaining black-body radiations even when the source to be measured is not enclosed, by placing a tube, closed at one end, in the hot space, and receiving the radiations from the open end. All that is requisite, therefore, is to obtain an instrument which will measure the quantity of radiant energy calibrated to read temperatures by the aid of the fourth-power law.

The first pyrometer on these lines was devised by Féry of Paris in 1902. It consisted of a kind of telescope, the object-glass of which focussed the rays from the hot source on a tiny thermal junction, after the fashion of a burning-lens. The thermal junction was coupled up with a delicate galvanometer, which by its deflections measured the relative quantities of energy falling on the junction under varying conditions. By taking one accurate reading of a furnace kept at a known temperature, the whole scale of the galvanometer could be divided so as to read in temperatures directly; thus if a known temperature of 927° C. (1,200° abs.) gave a deflection corresponding to 2 millivolts at the galvanometer terminals, then 5 millivolts at the terminals would represent a temperature of 1,227° C. (1,500° abs.). This value is calculated from the fourth-power law as follows:—

$$\frac{R_1}{R_2} = \frac{T_1^4}{T_2^4};\ \therefore\ \frac{2}{5} = \frac{1200^4}{T_2^4};\ \therefore\ T_2 = 1500^\circ \text{ abs.}$$

The temperature corresponding to any other deflection could similarly be calculated and marked on the scale.

In this form Féry's pyrometer suffered from a grave defect, which prevented a strict application of the radiation law to its readings. A large proportion of the radiant energy from a heated source cannot pass through glass, as we may observe from a simple experiment with the thermopile. I place a yellow gas flame in front of the instrument, and we obtain a deflection on the scale of the galvanometer. I now interpose a sheet of ordinary glass between the flame and the thermopile, and immediately the deflection falls off considerably. The proportion of the rays thus extinguished does not, moreover, bear any uniform relation to the temperature of the hot source; and although this difficulty might be overcome by the use of a fluorspar lens in place of the glass objective, the cost of such a

lens would make the instrument prohibitive for industrial purposes.

In 1904, however, Féry solved the problem by using a concave mirror to focus the radiations on the junction. I will repeat an old experiment to show how radiations may thus be focussed. Facing each other, on opposite sides of the room, are two concave mirrors, and in the focus of one is placed an electric arc, the rays from which strike the mirror behind it, and pass in a parallel beam to the opposite mirror, which brings them to a focus. I place a piece of guncotton in this focus; it immediately ignites; and a sheet of paper held in the same spot soon bursts into flame. The first mirrors used by Féry were faced with silver, which soon tarnishes in a workshop; but by using a gold reflecting surface this trouble was overcome. The construction of the pyrometer as now used is shown in the slide (Fig. 14), in which C is the concave mirror and R the junction on which the rays fall. The junction is made as small as possible, and possesses a dull, black surface, so that every type of radiation falling on it is almost completely absorbed and converted into heat. Terminals from this junction pass to a d'Arsonval galvanometer, which has a suspended coil, and which gives deflections proportional to the energy absorbed by the junction, and is marked with a temperature scale as previously explained. Now the position of the focus formed by a concave mirror varies according to the distance of the object focussed, and as the image of the hot substance must be formed exactly on the junction, some accommodation is necessary. This is furnished by a rack and pinion movement, by means of which the position of the mirror may be adjusted by turning the milled-head E. To discover when the focus is correct, a small telescope is provided, fixed opposite to a hole in the centre of the mirror. By means of an ingenious optical device, the image of the hot substance produced by the mirror is reflected back to the telescope in the form of two semi-circles, and the focussing process consists simply in moving the mirror until the two half-moons form a full moon or continuous circle, when the temperature may be immediately read off on the scale. The thermal junction is visible through the telescope, and so long as it is completely overlapped by the image the same temperature is recorded. For, although the radiant energy entering the instrument falls off as the square of the distance, this is balanced by the fact that the area of the image formed by the mirror diminishes in like ratio; and whereas at long range the whole of the reflected rays may impinge on the junction, at a small distance from the hot body the image is so large that the greater portion does not strike the junction at all, but passes after reflection out of the end of the tube. As constructed for workshop use, a heated object one foot in diameter will give the same reading at any distance up to twelve yards.

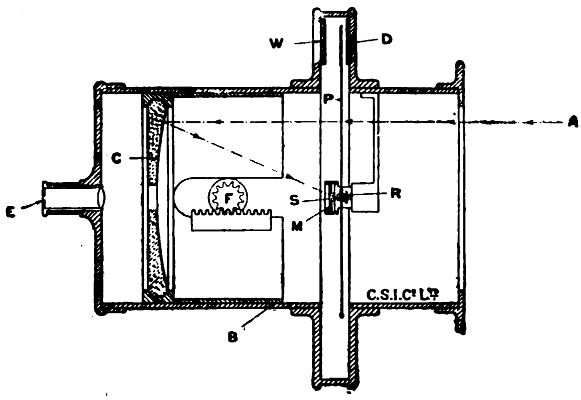

Fig. 14.—Section of Féry's Radiation Pyrometer, Spiral Form.
(In the ordinary form the Spiral S is replaced by a Thermal Junction.)

The history of the evolution of the Féry pyrometer furnishes one of the most striking examples of the manner in which a number of discoveries may be blended into a most useful instrument. Eight great names are inseparably connected with this device; the sighting telescope recalls Galileo; the concave mirror for bringing the rays to a focus in this form takes us back to Newton; the thermal junction was the discovery of Seebeck; the moving-coil

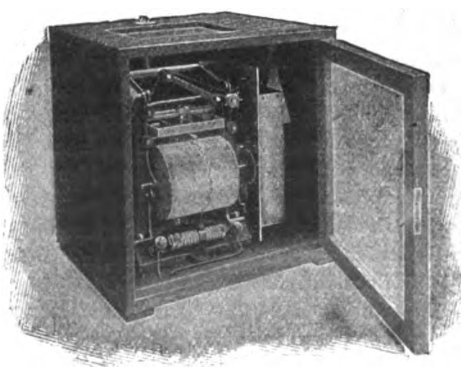

Fig. 15.—Thread Recorder, for use with Féry Pyrometer, or any Thermo-electric Instrument.

galvanometer originated with d'Arsonval; and the fourth-power temperature scale enshrines the names of Kirchoff, Tyndall, Stefan and Boltzmann. And, in all justice, we should add as a ninth name that of Féry, who so ingeniously combined the work of his predecessors.

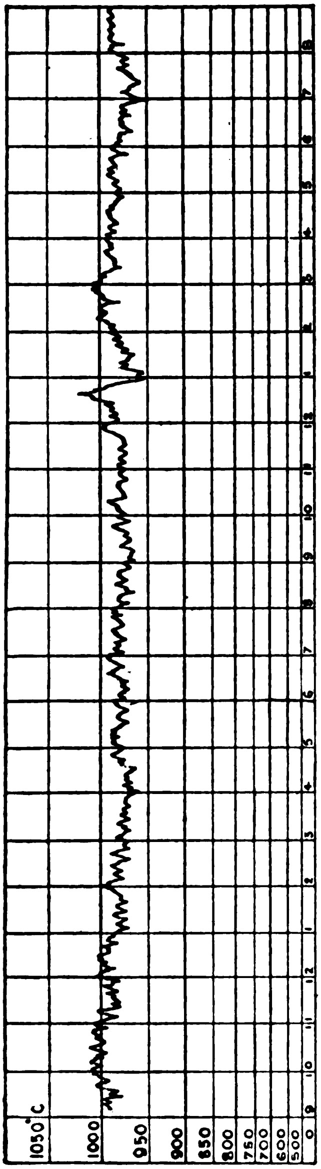

Fig. 16.—Record taken with Féry Pyrometer and Thread Recorder.

We will now pass on to the consideration of the industrial uses of this pyrometer. It may be used in all cases in which the temperature is too high to permit of the continuous employment of an instrument which must be in contact with the source of heat, such as in pottery-kilns, steel-smelting furnaces, glass-kilns, cement-kilns, etc. It can be made to suit any desired range, and has been used to measure such great temperatures as that of the arc-lamp—3,700° C. or 6,700° F.—and is rapid and consistent in its indications. As the secondary principle of the instrument is thermo-electric, records may be taken by means of any good recorder used in conjunction with ordinary pyrometers of this type. Fig. 16 is a sample of such records. The outfit, moreover, is portable, and may be carried from furnace to furnace, which is an advantage over fixed instruments. It is not liable to get out of order with ordinary care, and is easy to use. Care should always be taken, however, to use this pyrometer under black-body conditions, either by sighting the object whilst still in the furnace, or on the end of a closed tube inserted with the end in contact with the source of heat.

The latest development of radiation pyrometers is due to Foster, who has designed an instrument which, within reasonable working limits, gives a correct reading without requiring to be focussed. The action of Foster's fixed-

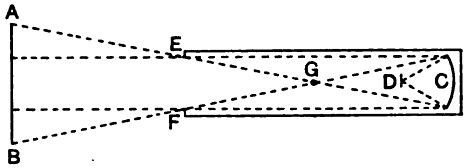

Fig. 17.—Principle of Foster's Fixed-focus Pyrometer.

focus pyrometer will be understood from the diagram (Fig. 17), in which C is the mirror and D the thermal junction, enclosed in a tube with dull, black walls. At the entrance of the tube is an opening, E F, which has sharp edges; and if lines be drawn connecting the extremities of the mirror C with E and F, and produced to the hot substance A B, the same effect on the junction D will be obtained at any distance, provided that the lines G E and G F, when continued, fall on A B. The instrument is so constructed that if A B represent an object six inches in diameter, the same reading will be obtained at any point within five feet of the heated body. As in the Féry pyrometer, a galvanometer graduated in accordance with the fourth-power law is used; and records can similarly be secured with a thermo-electric recorder.

In cases where only a fairly approximate reading is desired, a modified form of Féry's pyrometer may be used, in which the thermal junction is replaced by a bimetallic strip, bent

into a spiral form (Fig. 18), to which a pointer is attached. An increase in temperature causes the spiral to uncoil, and the pointer is thus caused to travel over a scale on which temperatures of the hot source are marked. The general arrangement is the same as that of the Féry pyrometer previously described; and as no galvanometer is necessary, a simplified form of instrument results, the indications, however, being less accurate than those of the ordinary pattern.

So far, we have only considered in this lecture pyrometers based upon the law which governs the total energy radiated. There exists, however, another class of instruments in which an individual ray, selected from the visible part of the spectrum, is made by its intensity to give a

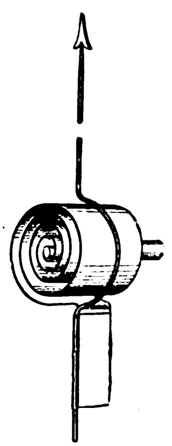

FIG. 18.—SPIRAL USED IN FÉRY PYROMETER (FORM II.).

clue to the temperature of the source. The visible spectrum, obtained when rays from an incandescent source are passed through a prism, represents only a portion of the sifted energy. Beyond the violet end we may trace shorter waves which darken a sensitised paper, and beyond the red are to be found longer waves, which are best detected by absorbing them on a dull, black surface, when they become manifest as heat. The quantitative examination of the spectrum was first undertaken by Tyndall in 1863 by means of the thermopile, which, with its blackened face, converted almost all the rays falling upon it, both visible and invisible, into heat; and by noting the deflection of the galvanometer when the thermopile was placed in different parts of the spectrum, the energy represented by different wave-lengths was discovered. Langley, by the aid of the bolometer—an instrument far more sensitive than the thermopile, and working on the same principle as the resistance pyrometer—was able to map the distribution of energy in the spectrum more accurately than Tyndall; and the combined work of many physicists has resulted in several important generalisations, which have proved of great service in relation to the measurement of temperature. Time will not permit of a description of these valuable investigations, and we shall concern ourselves merely with one of the relations between wave-length and temperature which has been brought to light. It is known as Wein's formula, and is expressed thus:—

$$J = c_1 \lambda^{-5} \times e^{-c_2/\lambda T},$$

where J is the energy due to wave-length λ; T the absolute temperature of the radiating source (a black body); e the base of Napierian logarithms; and c_1 and c_2 constants. This formula is applied in pyrometry by measuring the photometric intensity of a ray in the spectrum—a ray in the red usually being employed. When readings at known temperatures, under black-body conditions, are taken, and the wave-length λ is known, the values of c_1 and c_2 can be determined; and afterwards the absolute temperature T, corresponding to a measured intensity J, can be calculated. Wein based his formula on thermodynamic reasoning from the distribution of energy in the spectrum, and certain points in the investigation are open to objection. Planck has amended the formula by introducing an expression which gives almost identical results with Wein's for short wave-lengths, but different for long. The important fact emerging is that Wein's law, when applied to a red ray from a black body, furnishes a temperature scale identical with that obtained by standard methods, and appears capable of indefinite extension. The temperature of the electric arc, as measured by an optical pyrometer calibrated according to Wein's law, agrees very closely with the figure obtained with a total-radiation pyrometer with a scale calculated from the fourth-power law. We may reasonably conclude, therefore, that the intensity of a portion of the visible spectrum may be employed to give correct readings of the highest temperatures attainable.

Of the several varieties available, I shall select one for detailed description, namely, the Holborn-Kurlbaum optical pyrometer, as this instrument is the simplest, both in construction and use. It consists (Fig. 19) of a telescope, in

the focal plane of which is placed an electric lamp L, furnished with a carbon filament of hair-pin shape, as shown in section at A. In series with this lamp is a battery, a rheostat R, and a milliammeter M, which records the current passing through the lamp. In front of the eye-piece of the telescope two pieces of red glass, D, are placed; and on looking into the telescope a red field, due to the heated object, is seen, upon which the filament of the lamp is superposed. The adjustment consists in altering the resistance R until the filament is brought to the same brightness as the surrounding field, when the current indicated by the milliammeter is read. It would be a somewhat tedious matter to show how readings of current may be translated into temperatures by the aid of Wein's law; and it must suffice to state that a table may be calculated from which temperatures corresponding to milliamperes may be read off. If the temperature of the source exceed that of the lamp at maximum current, the absorbing device E, consisting of two mirrors of dark glass, is placed on the end of the telescope, so that the brightness of the source is reduced below that of the lamp at full current. A second temperature scale is prepared for use with the instrument when the absorber E is employed, and indefinitely high readings can be obtained. One of the advantages of this pyrometer is the ease and certainty of the adjustment; and it may be added that the masterly researches of Waidner and Burgess at the United States Bureau of Standards during the past few years on the highest attainable temperatures, have been conducted by the aid

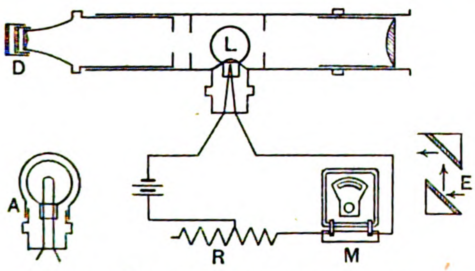

FIG. 19.—HOLBORN-KURLBAUM PYROMETER.

of this instrument. It is manufactured for industrial use in this country by Messrs. Siemens, one form being mounted on a tripod-stand (Fig. 20) for use in a fixed position; whilst a second form (Fig. 21) is made so as to be portable. This pyrometer is of great service for temperatures exceeding 1,200° C., and may be used with equal advantage for lower readings.

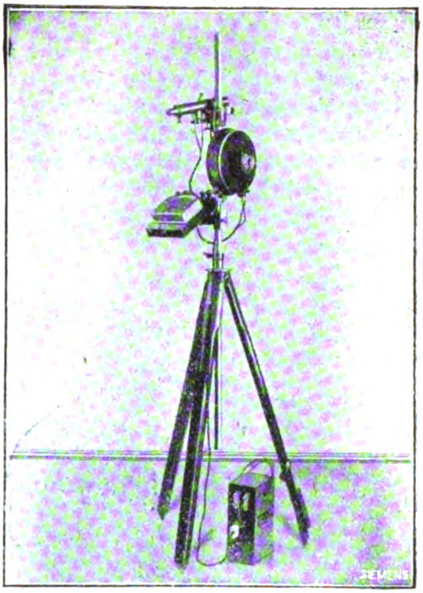

FIG. 20.—SIEMENS' OPTICAL PYROMETER, FOR FIXED POSITION.

(Workshop Form of Holborn-Kurlbaum Pyrometer.)

It cannot be adapted, however, to the taking of records—a defect common to all optical pyrometers.

Several other forms of optical pyrometer are in use, which require in the adjustment the equalising of the colours of two fields, one due to the standard and one to the source; or the production of a special tint. In the Wanner pyrometer red rays from the source and standard are obtained by means of prisms, thus securing monochromatic light, and are brought to equal brightness by a polarising device; whilst in Féry's optical pyrometer rays from the source are passed through two wedges of darkened glass, which are capable of sliding over each other, and are moved until the source is reduced to the same brightness as the standard. Both are capable of calibration by Wein's law. In the Mesuré and Nouel pyrometer, which is a polarising arrangement, the relative brightness of the red and green portions of the spectrum is the principle relied upon, and the adjustment consists in producing a neutral yellow tint by rotating an analyser. The calibration in this case is empirical.

In conclusion, I trust that this course of lectures has made evident the great industrial importance of pyrometry, and will assist in producing an increased appreciation of the value of high temperature measurements. It will

have been gathered that each type possesses advantages peculiar to itself; and the choice of an instrument should always be preceded by a careful consideration of its suitability to the purpose intended. No branch of science better demonstrates the utility of laboratory research in connection with industry; but after all, there exists no real partition between the laboratory and the workshop.

FIG. 21.—SIEMENS' OPTICAL PYROMETER, PORTABLE FORM.

[The following instruments were exhibited:—

(1) A Féry radiation pyrometer, ordinary type, with Thread recorder; (2) A Féry radiation pyrometer, spiral type; (3) A Féry optical pyrometer. By the Cambridge Scientific Instrument Company.

(4) A fixed-focus radiation pyrometer, by the Foster Instrument Company.

(5) Commercial form of Holborn-Kurlbaum Pyrometer, by Messrs. Siemens & Co.

(6) A Mesuré and Nouel pyrometer, by Messrs. A. Gallenkamp & Co.]

BRITISH CAPITAL IN THE UNITED STATES AND THE COLONIES.

In a paper recently read before the Royal Statistical Society, Mr. George Paish gave some interesting particulars relating to the amount of Great Britain's capital investments in the United States and the Colonies. He estimates the total amount of British capital invested in the United States at the enormous sum of £688,000,000. Of this nearly £600,000,000 are in railway securities, £31,500,000 in "finance, land and investment," and £21,500,000 in mines.

After the United States, Great Britain has provided more capital to Canada than to any other country, and the rate at which the British people are now increasing their investments in Canada is extremely rapid. The amount of visible capital our investors have placed in Canada now reaches the great sum of £373,000,000, and new supplies of visible capital are flowing to Canada at the rate of over £30,000,000 a year.

Including the visible capital, says Mr. Paish—that is, the capital privately supplied for loans on mortgage, the purchase of land for the conduct of private businesses, etc.—the amount is probably nearly £40,000,000 a year. The amount of visible capital we have sent to Canada in the last three years has reached £100,000,000. Canada still needs a large sum of money for the completion of the railways now under construction, and inasmuch as the Mother Country is proud of the great progress of her daughter, and is willing to supply her with all the capital she needs to develop her resources, it is evident that our capital investment in Canada will reach a much greater total in a few years. Practically the whole of the capital which has been spent upon railway construction in Canada has been provided by the investors of Great Britain. In the 'nineties, when our investors were suffering from a feeling of distrust of other nations, including the Colonies, the progress of Canada was very slow, and the increase in her population relatively unimportant; but in recent years the ability of Canada to obtain all the capital she needs for the development of her natural riches has stimulated the growth of her population in a wonderful manner.

The British people have provided the Australasian Colonies with nearly as much capital as they have supplied to Canada, the visible amount reaching the great sum of £380,000,000. Of this total, £301,500,000 has been supplied to the Commonwealth, and £78,500,000 to New Zealand. A few years ago the amount of capital supplied to the Australasian Colonies was much greater than that invested in Canada, but the rapidity with which Canada is developing, and the relatively slow progress of the Australasian Colonies have materially changed the situation. In the 'eighties there was a great flow of British capital to Australasia for railway construction, and population increased at a rapid rate; but in the 'nineties the country fell upon misfortune—first, because British investors were not willing to find much new capital in

consequence of their distrust of Colonial and foreign investments at that time; and, secondly, because Australia was visited by a series of droughts which seriously checked her progress. In recent years the credit of Australasia has been fully restored, and the measures that are now being taken to increase the productive power of the country and to develop its natural resources will, doubtless, bring about the influx of a greatly increased amount of capital from this country, and thus stimulate the growth of population and of wealth. Last year the amount of new capital raised in London for Australasia was some £10,000,000. About two-thirds of the capital invested by the British people in Australasia has been provided by loans to the various Governments. The object of these loans was railway construction and other public works. The circumstances of Australasia were such that it was more desirable for the country to use its own credit in order to secure the necessary capital for railway construction than to leave railway extension to private enterprise. In Canada the circumstances are different, and the Canadian people have been able to get all the capital they require for railway construction by means of companies and by private enterprise; but although the methods of obtaining the capital have differed, the railways both of Canada and of Australasia have been almost entirely constructed by means of the capital supplied by the Mother Country.

The investment of the British people in South Africa is also of vast extent. The amount reaches the great sum of £351,000,000. Of this total, £125,000,000 is the capital of mining companies, £97,000,000 loans to the various Governments of South Africa, and £73,000,000 is the capital of land and investment companies. There is a certain amount of duplication in these totals, as the investment companies hold large amounts of mining shares. Although the purely trust companies have been excluded, a certain amount of duplication is unavoidable. Nevertheless the greater portion of the £73,000,000 of capital which we have found for land and investment companies is not duplication, but represents the actual investments of those companies in land and property. This total includes the capital of the British South Africa Company, amounting to £8,250,000. The loans to the Governments have been mainly spent on railway construction, as well as the £9,000,000 of capital which we have supplied to railway companies.

The amount of visible capital we have found for our great Indian Empire is no less than £365,000,000, the larger portion of which has been for the construction of railways. The capital of the railway companies is £137,000,000, and the Government loans of £179,000,000 have been mainly for railway purposes. The capital of tea companies provided by our investors is nearly £20,000,000. No one can doubt the beneficent effect upon the prosperity of India of this expenditure of British capital for the development of the natural resources of the country, and the linking up of district with district, which has so powerfully helped to diminish the severity of famines. This great sum has been lent to India at an exceptionally low rate of interest, and having regard to the immense increase in the wealth of the Indian people which has resulted, and is resulting, from the construction of railways, the burden of the low interest charge is quite negligible. Probably the improvement in the condition of the people resulting from railway construction, has been one of the most potent factors in maintaining the loyalty of the vast populations of India to the British Empire.

The investments of the British people in the minor Colonies are also of a large amount. For West Africa, where the rate of development has recently been rapid owing to the discovery of gold, the British people have found over £29,000,000 of capital, of which £12,000,000 has been for mines and £8,000,000 for Government loans, mainly for railways.

The recent development of the motor-car industry in this and in other countries, which has so greatly increased the demand for rubber, has induced our investors to place considerable amounts of capital in the Straits Settlements and Federated Malay States. The total visible amount of capital we have provided for these Colonies is about £22,000,000, of which over £10,000,000 is for rubber and £8,000,000 for Government loans.

EGYPTIAN CIGARETTES AND TOBACCO.

Egyptian cigarettes are only Egyptian as regards their manufacture. The raw tobacco of which they are made comes almost entirely from Turkey. Greece furnishes a certain quantity of the tobacco imported into Egypt, but most of this is sold by the pound, and is not made into cigarettes in the manufactory, although the poorer Arab purchasers use it to make their own. An attempt was made some years ago to grow tobacco in Egypt, but it was found that only an inferior kind could be produced, the climate not being favourable to the growth of the plant, although it suits the manufacture. The growth and sale of this inferior tobacco encouraged smuggling, so the Government bought all the home-grown tobacco in the Customs and burnt it. The high duty on tobacco in Egypt makes it only worth while to bring the best quality into the country, and whereas the Arab of fifteen years ago, accustomed to the Egyptian-grown weed of inferior flavour or to others equally lacking in good aroma, would contentedly smoke a very poor article, he is to-day much more of a connoisseur. Mr. Matossian, one of the chief cigarette and tobacco manufacturers in Egypt, informed the writer that the inferior leaves in the bales are now re-exported to Hamburg, Bremen, and other towns to fill the cigars manufactured in those places. The poorest Arab now demands something better.

The districts that furnish most of the tobacco imported into Egypt are Samsoun, Bafra, Smyrna, Trebizond, Cavalla, Ismidt, Bulgaria, Bosnia, and

Herzegovina. The import duty is 20 piastres (4 shillings) a kilo. The big firms buy one year's crop for the next year's tobacco and cigarettes. The storage is an art in itself. For instance, certain qualities are not brought into Egypt for many months after purchase, but are left to mature in Turkey, as certain phases of the Egyptian climate would be detrimental to them. Other qualities, when they arrive in Egypt, have to be arranged in a special way, with three or four other bales on the top. Some have to have only one on the top. It depends on the quality and on the maturing required. Thus the immense quantities purchased by a very big firm make it possible, by means of mixture, special packing, acclimatisation, and so on, to keep the quality uniform. Careless, or possibly ignorant packing has sometimes produced spontaneous combustion and caused a serious outbreak of fire.

The first and most important piece of work in cigarette-making is the mixture. The bales are filled with small, flat bunches of tobacco leaves, about a dozen in each. Experts sit surrounded with large baskets, and as each little bunch is untied leaves are distributed into the baskets according to their quality. Speaking generally, the large and golden-coloured leaves belong to the inferior kinds, whereas those to be used for cigarettes are smaller and of duller hue. No smoking is allowed in the manufactories, and they are kept beautifully clean and airy. The air is delicious with the mild, clean fragrance of the best tobacco. Whilst the "mixture" is being made the leaves are gently sprayed with water. The best quality is reserved for the making of cigarettes, other kinds are used for tobacco of different qualities, with which the native makes his own cigarettes.

The next process is the cutting. In very large factories the knife of the cutting machine is worked by machinery and moves with great rapidity, the machine being fed by hand in quantities of several pounds at a time. It is claimed, however, that the best cigarettes of all are those made by the smaller machines in which the knife is worked by the workman and not by machinery. The leaves intended for cigarettes are not chopped so finely as those intended for tobacco to be sold by the pound. English cutlers have so far not been successful in the knives that they have supplied for tobacco cutting. They have not the requisite experience for tempering the steel to the exact requirements of this industry. In a large factory such as Melachrino's, Gianacli's, or Matossian's, where from 1,200 to 1,500 workpeople are employed, there will be perhaps fifteen cutting machines, made for the most part in England, with the exception of the knives. The weighing machines are also of English make. A table with scales is beside each machine and each machine has a revolving counter, that moves very slowly, attached to it. The workman weighs his pounds or half-pounds of tobacco, emptying them into the saucers in the revolving counter. The latter open to let each quantity fall into one of the chain of small tin buckets that the machine circulates. In a direction opposite to that taken by the buckets, rows of glazed and printed papers approach from another part of the machine. At a certain point the tobacco from each bucket is emptied on to a square of paper which is gripped by tweezers under the machine and folded into a packet of tobacco that only requires to be sealed. There are different colours for the different qualities.

Large firms, such as Matossian's, engage in the complete tobacco industry, preparing tobacco to be sold by the pound as well as cigarettes. Many smaller firms engage in cigarettes alone. In the smaller firms each cigarette is made entirely by hand. The paper rolls are made as follows:—Each worker has a small quantity of paste on a clean marble slab. The cigarette papers are folded very deftly round a small wooden ruler, and then fastened with paste at the edges. Practice gives an almost incredible swiftness. As the papers are white, spotless cleanliness in all respects is a necessity. As they are made they are passed, hundreds at a time, to a child at the end of the room, who gives each cigarette case a very slight depression between finger and thumb, to give the correct slightly flattened shape. These are passed on to another set of workers to be filled.

As has been already said, the tobacco for cigarettes has the fibre left much longer than that to be sold by the pound. The method is as follows:—A piece of strong paper, slightly larger than that required for a cigarette case, is fixed at one end to each worker's table. On this he lays about as much tobacco as is wanted for the cigarette, and folds the loose end of the paper round until it takes the form of a cigarette. End to end with this an empty paper case is laid, and then the tobacco (already rolled into the required shape by the fixed piece of paper) is pressed into the empty case by a slender wooden ruler, similar to those used for making the cases. A good worker will fill from two to three thousand in a day, and earn from £2 to £3 a week.

In the large factories machines are now used, which obviate hand labour, but connoisseurs declare that this is no improvement to the smoker. In these the tobacco is put into the machine at one end and slips of paper at the other. At a certain point gum, or some adhesive mixture, drops on to the papers, and at the end a perfectly-made cigarette drops out that only requires clipping at the ends. One of these machines is supposed to do 500 a minute; another guarantees 600, but is worked at 290. Many manufacturers in Egypt have the boxes for their cigarettes made and printed in England. Those for use in Egypt are of cardboard; those for export are of tin. Time is saved in packing boxes by slipping bands of glazed paper round 50 or 100 cigarettes and dropping them into the boxes.

The following list shows the amount of cigarettes exported from Egypt between the years 1906 and

1909, and the customs duty paid in Egyptian pounds. An Egyptian pound is $5\frac{1}{2}d.$ more than a pound sterling.

Year.	Kilos Exported.	Customs Dues.
1906	590,047	£E465,863
1907	452,962	393,503
1908	456,258	364,887
1909	447,222	364,781

The following table shows the countries to which cigarettes were exported and the number of kilos sent to each between January 1st and December 31st, 1909:—

Country.	Kilos.
Germany	108,223
England	79,276
English Possessions in the East	55,169
Austria-Hungary	51,245
Sweden and Norway	46,519
France	31,832
China and Farthest East	29,146
America (United States, 3,979; other Countries, 12,373)	16,352
Belgium	13,107
Switzerland	8,920
Italy	5,414
Holland	7,071
English Possessions in the Mediterranean	2,501
Denmark	617
French Possessions in the Mediterranean	329
Spain	689
Portugal	375
Russia	181
Greece	156
Massana	15
Total	457,232

The export of Egyptian cigarettes to England has fallen off of late years, owing to the high customs duty, but so-called "Egyptian" cigarettes are made in Germany in large quantities, in appearance exactly similar to the genuine article, though very different in aroma.

THE SUGAR-MAKING INDUSTRY IN INDIA.

India is the greatest cane sugar-producing country in the world, but notwithstanding this fact, its sugar market has been captured first by the beet sugar, and later by cane sugar from Mauritius and Java. This condition of affairs has been brought about by the backward state of the Indian sugar-cane industry in the matter of machine appliances. It is estimated that with modern machinery and better organisation of the industry, India could produce 50 per cent. more sugar. Sugar cane is a crop particularly well-suited to the country, and, in the matter of sugar production, India ought to be an exporting rather than an importing country. The native mills are, according to the American Consul in Bombay, either the "kolhu," a mortar and pestle arrangement, in which the cane is bruised and pressed, or else wooden roller mills, of which there are two kinds—the "gundi," consisting of two, sometimes three, upright wooden rollers, and the "belna," used in the Punjab, and made of two horizontal wooden rollers. These mills are made locally, at a cost of from twenty-six to forty shillings. They are hard to work, and do the pressing very ineffectually. In many parts of India these old, clumsy, wooden mills are being replaced by the iron sugar mill. This improvement, however, was only effected after a close study had been made of native ways and requirements, and after the machines had been adapted to these. The cultivators had experienced a great deal of trouble in procuring an efficient machine for crushing purposes, as, owing to their lack of knowledge about machinery, the imported machine soon got out of order, with the result that the cane was imperfectly crushed. Most of the sugar produced in India is consumed in the form of "gur," or unrefined sugar (corresponding to the "Muscovado" of the West Indian planters), because of its adaptability for native sweetmeats and native cookery. The establishment of large central factories has been urged as a means of increasing the sugar yield of the country, and meeting the formidable competition of the imported article. Although there are a few factories of considerable size, most Indian cane is grown and manufactured by small cultivators. Under present conditions the large central factory is hardly practicable. The system of land tenure which obtains practically throughout the country is not adapted to such a system. The soil is divided into a number of small holdings, which produce a variety of crops, according to the fancy of the cultivator. It is practically impossible, therefore, to secure a concentration of sugar plantations around a factory, and so long as cane is only grown in small and isolated patches through a radius of many miles, the cost of handling and carriage, added to the loss of sugar in transit, handicaps the factory so much that success is out of the question. The portable iron mill, therefore, has been found more practical, the cheapness of Indian labour counterbalancing the economies practicable in the large central factories. About half the sugar cane produced in India is grown in the United Provinces. The American Consul states that Mr. W. H. Moreland, Director of Land Records and Agriculture, Lucknow, has given much time and attention to the study of the Indian sugar industry, and would, the Consul believes, be interested to learn of any new crushing machine which would be adaptable to the needs of the Indian cultivator. It is often through the agricultural departments of the various provinces that such things are brought into the country. It is not easy to introduce an article of this description into India, and unless firms are prepared to go to a good deal of trouble, and perhaps some expense, in learning the exact needs of India in respect to such machines, it will be useless to make any such attempt.

RUBBER CULTIVATION IN SOUTHERN ASIA.

The total area devoted to Para rubber plants at the end of 1909 in Malaysia was as follows: Federated Malay States 178,668 acres, Straits Settlements and Kedah 41,405 acres, Johore 28,883 acres, Kelantan 4,111 acres, making a total of 253,067 acres, upon which about 40,000,000 trees are planted. The total number of estates in the Federated Malay States was 377, with an acreage of 500,431. The total number of estates in the whole of Malaysia is 534, with an acreage of 855,992. The total rubber produced in 1909 was, according to the American Consul-General in Singapore, 6,741,509 lbs., an increase of about 100 per cent. over 1908. These are the official returns, but it is believed that the actual output was much greater. In the Federated Malay States rubber estate labourers numbered 77,525 in 1909, while the total number of such labourers in all Malaysia was 110,213. There was no serious disease on the rubber estates in 1909. Root diseases seem the most stubborn, but planters are alive to their dangerous and insidious character. A fungus disease attacking the branch and stem of the trees appeared on some estates, but prompt measures overcame it. White ants still give some trouble, but are no longer considered a serious pest. The business of plantation rubber growing has become the prime factor in the agricultural life of the Malay Peninsula, and naturally the Agricultural and Horticultural Show, held at Singapore in August 1910, made rubber its principal feature. Several buildings were devoted to the display of rubber and rubber machinery, and great interest was taken in this part of the exhibition. The progress of rubber cultivation in Malaysia is remarkable. Six years ago only 13,867 lbs. of rubber were exported. In 1909 the export had increased to 6,741,509 lbs., valued at over two million pounds sterling, and it is believed that the planters have only started in a great rubber era. Since 1902 there has been an upward movement in the price. It was three shillings a pound in 1902, six shillings in 1907, while in May 1910 it reached twelve shillings a pound. As the average cost is about one shilling and threepence a pound to produce and market, the enormous profit, under proper management, is apparent. The probable forty-five million rubber trees ready for "tapping" in 1915 should give a minimum yield of 90,000,000 lbs. Being in the rubber belt the southern islands of the Philippines should be excellent for the industry, and it is predicted that some day great and prosperous rubber estates will be established upon them. Cultivated rubber is still in the experimental stage in Siam. Several plantations have been started by Siamese officials in the States of Singora and Chumpon, and the trees are said to be thriving. In the region of Chantaboon there are many acres under cultivation, and the prospects for the industry there, according to the United States Consul at Bangkok, are encouraging. In the region of Gengkoi, near Korat, there is a considerable extent of land under cultivation. In Patani 58,000 trees are planted in an area of about 300 acres. The total acreage at present under rubber cultivation in Siam is about 3,000. Siam has a vast agricultural area, and only the minutest portion of the soil, which varies in quality from alluvial to mountain lands, has as yet been turned. Labour is comparatively cheap, and since both soil and climate are congenial to the growth of the rubber tree, here is practically an undiscovered country. The Siamese Government realises the possibilities to be derived from opening up the country to the cultivation of rubber, and arrangements are shortly to be made whereby concessions will be granted to intending plantation owners in Siam.

BELGIAN LACE MAKING.

The present number of lace makers in Belgium is stated to be 45,000 women and girls, as compared with 150,000 in 1875. At Turnhout, 2,500 lace makers produce "la dentelle de Malines," a superior article both in design and workmanship, but the majority produce "point de Paris," used for household furnishings, "point de Lille," sold in Holland and Brittany for trimming the characteristic caps worn by native women; "point de Binche," and torchon lace. The lace makers begin their apprenticeship at six to eight years of age, although the legal age limit is nine years. Their hours are from 6.30 to noon and 1 to 7 p.m. in summer, and in winter 8 a.m. to 10 p.m. They earn from fourpence to fivepence a day; the more expert earn sevenpence. The maximum wages paid to the most experienced lace makers never exceed fifteenpence a day, and out of 2,500 workers only about twenty are paid the maximum. Children up to twelve years of age, and even older, are paid tenpence per week. Relatively to its value, the lace workers producing the Malines lace are the most poorly paid. All lace makers are paid by the ell, the Flemish ell being twenty-seven inches. Those working in the schools earn less than those working for a local agent. It is largely due to the existence of intermediaries, or "middlemen," that wages are low. According to the American Consul at Liège, lace schools are either maintained by religious institutions, or are directed by more or less expert lace makers, who gather together the pupils, girls of different ages, in their dwellings, small workmen's houses, added to which are the workrooms into which the children are packed. Often seventy or one hundred workers are crowded into a space that would barely suffice for twenty people to move about in. The rooms are not heated. At nightfall the benches are ranged along the wall, and upon small round tables a petroleum lamp is placed, with flasks of clear water arranged so that the light traverses the water and falls on the lace-pillows of the workers. Lace workers attending these schools pay about fifteenpence per month. The director of a school must turn over all work to

the agent, so that sales in the open market are excluded. All lace produced is offered for sale whether good, bad, or indifferent, a fact that, it is claimed, has depreciated the industry and maintains the low scale of wages that prevails. The lace maker's skill is only developed mechanically, anything like artistic training being lacking, which partly accounts for the large amount of inferior lace found on sale. For improving the condition of the lace workers, and lending support to one of the oldest and most attractive of Belgian industries, a new school has been organised that will consolidate all existing schools and employ those teachers now working separately.

ARTS AND CRAFTS.

Lettering.—One is hardly inclined at first sight to connect a General Election, however remotely, with anything in the way of art. It is natural enough to look upon such an event as productive possibly of all sorts of good and evil results in one way or another, but as regards art (except perhaps the art of caricature) we take it for granted that it has no influence whatever. It would, perhaps, be saying too much to contend that the last election "influenced" art, but there is no manner of doubt that it served to emphasise, and to call attention to, the great strides that have been made in the last few years by a very useful and, until recently, much neglected branch of art. It is only of late that, owing first of all to the efforts of one or two energetic designers and somewhat later to those of a group of enthusiastic scribes, working artists and craftsmen have paid much attention to the subject of lettering. Those who are interested in the matter have noticed how slowly but surely the lettering on posters, advertisements, labels, notices, shop-fronts, and the like, has been improving, but it was left to a large full-page electioneering notice, which appeared in a good many of the newspapers, to bring home to our minds the tremendous gulf which exists between the presentment of such a thing, say ten years ago and to-day. This particular piece of lettering was simple enough, but it compelled attention and was quite undoubtedly, according to the political opinions of its readers, either worthy of the cause it served or deserving of a better one. The fact that this notice was faced in some papers by a counter-announcement, set up in extremely good type, only served to make the advance of taste in lettering more apparent. We can nearly all of us remember a time when notices of this kind would inevitably have been atrocities with which no one would have thought for an instant of associating the word "taste."

It is not only in connection with such flaring things as election announcements, however, that there have been opportunities of late of noticing the growth of taste and care in lettering and typesetting. Anyone on the look out for such things could hardly have failed to note in turning over the leaves of newspapers and magazines the improvement in spacing, setting up, and general arrangement of the publishers' announcements as a whole. Some are a good deal better than others, and one or two have just missed being what they were evidently intended to be, by a little over-effort; but, for all that, they are on the whole a very satisfactory collection.

Another direction in which improvement can easily be traced within the last few years is in the lettering of the street names in certain parts of London, and in the letter-forms, and general arrangement of notice-boards (with the exception, it must be admitted, of those advertising houses to be let or sold, which are almost uniformly unsatisfactory).

At this season of the year, Christmas and New Year cards afford an admirable opportunity of seeing how lettering on a smaller scale is progressing. And in this particular direction the movement cannot be said to be altogether a forward one. Two or three years ago there were some extremely simple cards on the market, consisting entirely of lettering, which were better than such cards were as a rule this year. But, on the other hand, the general standard appears to have gone up. The ordinary private cards printed for people whose taste could at best only be called "negative" or "inoffensive," are decidedly better than they were some years ago, and there is more variety in the kind of lettering employed. There is, too, less of the hideous straggling would-be ornamental current writing which seems to do all in its power to avoid keeping on a straight line. It is rather interesting in this connection to remark that a few of this season's cards were lettered in a way which showed that writers are beginning to remember the old writing-books of the sixteenth, seventeenth, and eighteenth centuries, and to turn to them for inspiration instead of going exclusively to more ancient sources.

Posters.—When we turn to posters, we find that the General Election has played a smaller part than might have been expected in the development of poster design. The space of time which divided this election from the last was so short, and the main political issues so much the same, that the electioneering posters were for the most part old friends, familiar to us all from their appearance on the hoardings only a few months previously. On the whole, the very simple, direct kind of posters after the type of those drawn by Hassall, and other well-known artists, seem to be on the increase, but the type which relies for its effect on a multitude of tints and shades is by no means extinct—indeed, there are more pictures of this sort about still than one would have expected to find, considering the rapidity with which the more direct kind of work appeared to be coming to the fore some years ago. In a few cases, too, it seems as though the advertisers of popular health resorts were returning to the older kind of colour scheme. Some

of these more elaborate posters are certainly effective, but it is the simpler pictures produced in a few vivid, pure colours which on the whole attract, and one might almost say compel, attention.

The lettering on the posters varies very considerably in quality. As a rule it is better than it was some years back. The sloping, highly-shaded inscriptions so common then, are now hardly ever to be seen, at any rate on hoardings in the City and West End (poster design does not show improvement as one travels eastward from Aldgate), but a good deal of the writing is vulgar—and quite unnecessarily so, for a good simple, well-proportioned letter is much more attractive to the eye than an ugly and clumsy one, and distinguishes itself far better from its surroundings. Some of the big railway companies have been advertising their holiday services in very simple but not untasteful fashion, but one of them has a quite hideous announcement which takes one back to the poster designs of twenty or more years ago. Just at the present moment, if it were not for the advertisements of rival electric lamps and of some of the theatres, the hoardings would be rather dull, but it is satisfactory to note that the plan of allowing some plain space between the different announcements, and of giving a certain amount of consideration to the appearance of the advertising space as a whole instead of seeing how many square feet of advertisement can possibly be crammed into it, seems to be still gaining ground.

Trade Bookbindings.—The Christmas season is always a good time for judging of the direction in which general taste is trending as regards trade bookbinding generally—and this Christmas has proved no exception to the rule. It was noticeable that amongst the numerous books got up evidently with a view to the Christmas market there were a great many volumes bound in soft leather and blind stamped—a form of binding which would not have been seen at all a few years ago. The more sumptuous books were, many of them, cased in vellum with a pattern in fine gold lines stamped upon them—and many of these bindings are remarkably satisfactory. Some of them, indeed, were at once so tasteful and so reticent that one was inclined to think at first sight that they were hand-tooled, not because they can be said to ape the hand-work but because the ornament is so much more judiciously used than is often the case with stamped bindings.

Perhaps the most marked feature about this season's book covers is, however, the prevalence of the practice of decorating the front cover with a picture printed on paper by the three-colour process. Some years ago great efforts were made to produce attractive casings by printing on the cloth in light-coloured inks. This was never altogether a success, as the ink had a tendency to thicken, and to produce an unpleasant rather blotted appearance. The effect of a picture printed on paper like an ordinary coloured illustration is, on the other hand, from one point of view, all that could be desired; and these illustrated covers to inexpensive children's books are not only dainty, but quite suitable. Again, to find a well-printed little medallion adorning a modestly got-up white-covered little booklet intended to take the place of a glorified Christmas card in no way shocks anyone's sense of fitness. When, however, a rather gaudy picture is pasted on to the middle of the front cover of a book dealing with a more or less serious subject, and offered for sale at half a guinea or more, one begins to feel that the fashion has gone rather further than is seemly. To begin with, it is artistically by no means an ideal form of decoration for such a purpose; and, to go on with, those of us who still read and who preserve our books with some care are woefully conscious that the appearance of a volume so decorated will probably, after it has been in wear for some years, and has, perhaps, been standing rather closely packed against other books, leave a very great deal to be desired. It is rather a pity that a method of ornamentation which is, for some purposes, quite admirable, should be run to death.

EMPIRE NOTES.

Forest Conservation in Canada.—An important convention, under the auspices of the Canadian Forestry Association, has been summoned by the Prime Minister of Canada, to be held in Quebec from the 18th to the 21st of the present month. The object of the convention is to discuss forestry problems, and particularly the question of conservation. The attention which has been called to the duty of conserving the national resources of the United States and the Dominion by the appointment of a joint commission on the subject, and by the work already done by that body, has resulted in quickening the interest of both Canadians and Americans in the question of their timber reserves. One important result of this movement has been the setting apart of the whole of the eastern slope of the Rocky Mountains by the Canadian Government as a timber reserve, and by the adoption by some of the provincial Governments of regulations dealing with timber cutting and fire ranging, and for the training of foresters. The importance of the forest products of the Dominion may be estimated from the following returns showing the values of the exports for the years 1880, 1890, 1900 and 1909:—In 1880 they amounted to 16,854,507 dollars; in 1890 to 26,179,136 dollars; 1900, to 29,663,668 dollars; and 1909, to 39,667,387 dollars. One of the most striking facts given in the table from which these returns are taken is the large increase in exports to the United States, where the rapid depletion of the spruce, hemlock and poplar supplies has created a good market for Canadian pulpwood. Great Britain has also become a large customer for this Canadian forest product. Of a total import of 427,515 tons of pulpwood in 1909, no less than 107,243 tons came from the Dominion.

It is satisfactory to note, however, that, though the present forest products, used and exported by Canada, are considerable, there are vast areas of timber land which have never been tapped, of which it is estimated that 500 million acres consist of timber suitable for pulp.

The Zoological Gardens and South Africa.—The Zoological Gardens, Regent's Park, will be enriched by a collection of animals representative of the fauna of South Africa, by or before the end of this year. It had been originally intended, by the South African Zoological Society, to present a number of animals to the then Prince of Wales, on the occasion of his proposed visit to South Africa to open the Union Paliament; but, owing to the alteration of the plans necessitated by the lamented death of King Edward, the matter fell into abeyance for the time. The visit of H.R.H. the Duke of Connaught has, however, revived the proposal, so that the original intention will now be carried into effect, under an influential committee, representing the various provinces of the Union. Some rare birds, including a pair of the largest and rarest bustards known, have already been sent to London, and a pair of lion cubs, presented to the Duke of Connaught, which will form part of the collection, are expected to arrive in a few weeks. There is no doubt, from the interest which is being taken in the subject in South Africa, that a very valuable collection will be got together, which will form an interesting souvenir of the Union, and be a considerable attraction to the Gardens.

East Africa Wheat Supply.—In estimating the value of the Empire's sources of food supplies, it is gratifying to hear that East Africa expects to be able, within the next few years, to export a considerable surplus of wheat for the home market. The area under wheat cultivation in the Protectorate is rapidly extending, and is now nearly sufficient to meet all the requirements of the country itself. Samples of the wheat, examined and tested at the Imperial Institute, show that they would command a ready sale in the United Kingdom at prices comparing favourably with the finest description of imported grain. It has been found, too, that edible beans grown in East Africa may find a good market here, especially "haricot" and "butter" beans, while other varieties have proved equally satisfactory for cattle food.

The United States and Canadian Immigration.—In a recent report to Congress, the Chairman of the United States Immigration Commission compares the statistics of immigration into Canada during the last ten years with those of the United States, and he says that, while 70 per cent. of Canada's immigrants for that period came from Northern and Western Europe, and only 30 per cent. from Southern and Eastern Europe, it was the reverse with the United States. He states also that, during the last three years, more than seven-eighths of the emigrants from the States to the Dominion were classed as farmers or farm-labourers. Further, he shows that, from 1900 to 1909, of 225,690 homesteads taken up in Western Canada, 44·91 per cent. were applied for by settlers from the United States, 20·32 per cent. from England, 5·20 per cent. from Scotland, 1·89 per cent. from Ireland, and 27·07 per cent. from Continental Europe. These facts are of great interest, and show that the United States authorities are alive to the comparatively high quality of the immigrants which Canada is receiving. A further interesting comparison is furnished in a report of Mr. J. Obed Smith, the Assistant Superintendent of Emigration in this country, who states that, in the first ten months of this year, the number of emigrants from the United Kingdom to Canada was 149,420, as against 121,273 to the United States, while, for the same period last year, the numbers were 80,888 and 99,603 respectively. This is satisfactory, as, however cordial may be the relations between this country and the United States, it is certainly desirable, from an Imperial point of view, that British emigrants should settle in British lands.

The Financial Outlook in South Africa.—The Union Government enters upon its first financial year with excellent prospects, as, although the Minister of Finance anticipates a deficit of £1,451,000, there is a surplus of £1,220,000 from the railways, which he has decided to appropriate. This amount, and the amount realisable from the extension of the 10 per cent. Transvaal gold mines tax to the diamond mines of Kimberley and the Orange Free State, will, it is estimated, supply him with £9,000 over the balance. This is certainly most satisfactory, and well justifies the confidence of the new Government in their financial position. The question of the consolidation of the debts of the various provinces will, it is understood, very early occupy the attention of the Finance Minister, since, unlike the Australian Commonwealth, which "may" take over the debts of the Federal States, the Union Government of South Africa must do so. But although difficulties will have to be faced, there is no doubt that the result will be greatly to the advantage of the country.

The Exhibition at Allahabad.—At the opening of the United Provinces Exhibition at Allahabad on December 1st, 1910, Sir John Hewett, referring to the Agricultural Court, characterised it as the most important feature of the Exhibition, and drew special attention to the display of agricultural machinery, which he regarded as opportune, in view of the advance of wages in the provinces, which naturally causes landholders and large cultivators to adopt labour-saving implements. "It is a matter of special satisfaction," he said, "that many large manufacturing firms have realised the importance of this great undeveloped market, and, not content with exhibiting their standard machines, have spent much time in designing machines specially suited to the peculiar

conditions of the country." But, while he spoke highly of the exhibits, he urged the necessity of manufacturers and their agents following up the work which the Exhibition had so well begun. "Agencies," he stated, "in the distant cities of Calcutta and Bombay have not, as yet, the local knowledge of the local resources required to develop the market of Northern India, nor can they maintain the close touch with the Government agricultural departments, which is so necessary to success in the early stages of the campaign." It is satisfactory to know that the exhibitors, among whom are representatives of some of the leading British manufacturers of agricultural implements, have endeavoured, so far, to meet "the peculiar conditions of the country," but there is doubtless great wisdom in the suggestion that the Exhibition should be regarded only as a starting point, and that, to realise the full advantage which the agricultural development of the Northern Provinces offers, the work must be diligently followed up.

Tasmanian Mining.—It is reported that a valuable discovery of mineral-bearing country has been made in the area of the Stanley River Tinfield, Tasmania. A rich lode had previously been found at Mount Lindsay, a spur of the Parson's Hood Range. This lode shows 4 feet of ore, estimated to carry 30 per cent. of tin, and a formation 60 feet in width, which is highly stanniferous. But this find has been dwarfed by a report stating that there is a stretch of country, some 600 feet wide, running north-west and south-east, which carries gold, copper, and tin. The formation has been proved to extend over half a mile in length, and, at the height of about 400 feet, carries a saddle into the Wilson Watershed at Stanley River. The formation is said, for the greater part, to consist of mica, containing a large percentage of tin, and offers little or no difficulty in treatment. This discovery will strengthen the Government in their resolution to provide better means of communication for the district, by which the Stanley Reward and other mines in the neighbourhood may be profitably developed.

GENERAL NOTES.

BOOKS OF THE YEAR.—According to the *Publisher's Circular*, the total number of books published in this country during the year 1910 is 10,804, showing an increase of 79 on the total for 1909, in spite of the occurrence of two General Elections and the lamented death of His Majesty King Edward VII. The returns have been analysed as follows:—(1) Religion, Philosophy, etc., 1,064; (2) Educational, Classical and Philological, 659; (3) Fiction, Juvenile Works, etc., 2,833; (4) Law, Jurisprudence, etc., 248; (5) Political and Social Economy, Commerce, etc., 816; (6) Arts (fine and useful), Sciences, etc., 1,254; (7) Voyages, Travels, etc., 604; (8) History, Biography, etc., 860; (9) Poetry and Drama, 590; (10) Year Books and Serials in Volumes, 488; (11) Medicine, Surgery, etc., 398; (12) Belles Lettres, Essays, etc., 272; (13) Miscellaneous (including Pamphlets), 718.

A GREAT SUGAR ESTATE.—It is not perhaps generally known that one of the finest sugar plantations in the world is in Colombia. The Ingenio, Central Colombia, as Mr. Pro-Consul Stevenson shows in his report on the trade and commerce of Cartagena just published (No. 4,617 Annual Series), is not inferior to the very best estates of Cuba. It is situated in Sincerin, about twenty-eight miles distant from Cartagena, and along the Dique Canal, connecting this port with the River Magdalena. The first *zafra* (crop) of 1909-10 produced 5,082 tons of sugar, of which 1,903 tons were exported to the United Kingdom and 1,304 tons to New York. Early rains spoiled a large portion of cane plantations, or the production would have been much greater.

COTTON CULTIVATION IN EGYPT.—The Financial Adviser to the Egyptian Government has just issued a note on cotton cultivation which, on the whole, is encouraging. He anticipates that the total crop will exceed 6,750,000 cantars which, on the basis of the high prices prevailing, represents a sum accruing to the country much in excess of any recently recorded. The causes which, on the one hand, produced the very small crop of 1909, and, on the other, the relatively good results of 1910, remain obscure, but it is probable that the active measures undertaken by the Government against the cotton worm, the urgent recommendations given to the cultivator against excessive watering, the late flood, and the favourable autumn weather, have all contributed to the improved results. But there remains an unknown quantity as a factor in the situation of the two years, and it is necessary that the study of the various conditions affecting the cotton plant, which has now been seriously begun, should be carried on as actively as possible. An agricultural department is in course of formation, and a director-general has been chosen with wide experience of the subject with which he will have to deal.

TECHNICAL COURSES AT THE L.C.C. CENTRAL SCHOOL OF ARTS AND CRAFTS.—The following courses of lectures will be given at the London County Council Central School of Arts and Crafts, Southampton Row, W.C.:—On Silversmithing Subjects, on Tuesdays, January 10th, 17th, 24th, 31st and February 7th, by Messrs. J. Starkie Gardner, H. Wilson, G. A. Fournier and B. J. Tully; on Ancient and Modern Jewellery, on Fridays, January 13th and February 10th, by Mr. H. Wilson; on Book Production Subjects, on Wednesdays, January 11th, 18th, 25th and February 1st, 8th and 15th, by Messrs. Edward Johnston, R. W. Sindall, F.C.S., C. I. Smyth and Dr. J. Gordon Parker. The lectures will begin at 8 p.m., and members of the trades concerned are invited to attend.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

January 18.—John C. Medd, M.A., "The Dutch Labour Colonies." Lord Reay, G.C.S.I., G.C.I.E., will preside.

January 25.—Horace M. Wyatt, "Motor Transport in Great Britain and the Colonies."

February 1.—Philip Joseph Hartog, M.A., B.Sc., "Examinations and their bearing on National Efficiency." The Earl of Cromer, G.C.B., O.M., G.C.M.G., K.C.S.I., C.I.E., Vice-President of the Society, will preside.

February 8.—Captain A. J. N. Tremearne, B.A., D.Anth., "Some Nigerian Head-Hunters."

February 15.—George A. Stephen, "Modern Machine Book-binding." John Murray, J.P., D.L., F.S.A., will preside.

February 22.—Professor J. Wertheimer, B.Sc., B.A., "Water-Finders."

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

January 19. — Reginald Murray, formerly Manager, Chartered Mercantile Bank of India, London and China, in the Straits Settlements and India, "Banking in India." Sir Felix Schuster, Bart., will preside.

February 9.—R. A. Leslie Moore, I.C.S. (retd.), "Indian Superstitions."

March 16, April 27, May 25.

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

January 31.—F. Douglas Osborne, M.Inst.M.M., "The Tin Resources of the Empire."

February 28.—The Hon. Sir Richard Solomon, K.C.B., K.C.M.G., K.C.V.O., K.C., M.A., High Commissioner for the Union of South Africa, "The Resources and Problems of the Union of South Africa."

April 4.—Captain R. Muirhead Collins, C.M.G., "Australia and her Resources."

May 9.—F. Williams Taylor, "Canadian Banking."

Cantor Lectures.

Monday Evenings, at 8 o'clock:—

Frederick Wedmore, "Etching." Two Lectures.

Syllabus.

Lecture I.—January 23.—"The Old Masters." The Cradle of great Etching—Rembrandt's place—Ostade and Bega—Vandyke—Landscape and Animal Subjects in the Low Countries—The Classic Landscape — Claude — Links with the Moderns—Etching no "Minor Art."

Lecture II.—January 30.—"Modern Etching." Goya—Wilkie and Geddes—The Silence before the Revival—The great French Outburst—Méryon, Bracquemond and Jacquemart — Haden and Whistler—Themes mainly Landscape, Portraiture, Architecture—The Etching of To-day.

Professor Adrian J. Brown, M.Sc., "Brewing and Modern Science." Four Lectures.

Syllabus.

Lecture I. — February 6. — Introduction. Dr. Graham's Lectures Thirty-seven Years Ago—The Brewing Process a succession of Complex Biochemical Changes—Barley: Classification of types used by the Maltster—Barley from the Agriculturist's and Brewer's Points of View—Present Position of Knowledge regarding Characteristics of Malting Barley—Results of recent Experiments on Barley Cultivation in Ireland, etc.

Lecture II.—February 13. — "Malting." Constitution of the Barleycorn — Character of Changes during Germination—Investigations of the Biochemistry of Germination—The Barleycorn a highly-specialised seed, etc.

Lecture III.—February 20.—"The Mashing Process." The Chemistry of Starch and its Transformation Products—Protein Changes during the Mashing Process.

Lecture IV.—February 27.—"The Fermentation Process." Previous Treatment of the subject by Dr. G. Salamon in 1888—The Pure Yeast Question in Brewing—Zymase and Modern Views of Alcoholic Fermentation—Nitrogen Assimilation—The so-called "secondary" products of Fermentation, etc.—Conclusion.

Professor J. A. Fleming, M.A., D.Sc., F.R.S., "Applications of Electric Heating." Four Lectures.

March 6, 13, 20, 27.

Alfred E. H. Tutton, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

May 1, 8, 15, 22.

Dates to be hereafter announced:—

Frank M. Andrews, "Architecture in America."

Arthur Charles Davis, F.C.S., Assoc.Inst.C.E., "The Manufacture and Testing of Portland Cement."

George B. Heming, "Art Education in Jewellery and Goldsmithing."

Colonel Charles Edward Cassal, V.D., F.I.C., "The Adulteration of Food."

Dr. Leonard Hill, F.R.S., "Caisson Sickness and Compressed Air."

Sir William Abney, K.C.B., D.C.L., D.Sc., F.R.S., "The Quantitative Measurement of Colour-Blindness."

Hal Williams, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

Noel Heaton, B.Sc., F.C.S., "The Production and Identification of Artificial Gems."

Sir Thomas Henry Holland, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India." Lord Avebury, D.C.L., LL.D., F.R.S., will preside. (Indian Section.)

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 16...Illuminating Engineers, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Discussion on Library Lighting, to be opened by Mr. J. D. Brown (Islington Public Library) and Mr. S. L. Jast (Croydon Public Library).

Bibliographical, 20, Hanover-square, W., 5 p.m. 1. Annual Meeting. 2. Mr. R. Steele, "Some Sixteenth Century English Books with Spurious Imprints."

Engineers, Junior Institution of, Caxton Hall, Westminster, S.W., 7.30 p.m. Mr. L. W. J. Costello, "The Law Relating to Engineering." (Lecture V.)

Geographical, Burlington-gardens, W., 8.30 p.m. Sir John Murray and Dr. Hjort, "The 'Michael Sars' North Atlantic Deep-Sea Expedition."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. Halsey Ricardo, "Cardinal Medici's Pleasure House."

London Institution, Finsbury-circus, E.C., 5 p.m. Bishop Welldon, "Some Thoughts Suggested by Travel over the Empire."

TUESDAY, JANUARY 17...Royal Institution, Albemarle-street, W., 3 p.m. Professor F. W. Mott, "Heredity." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on papers by Mr. William Dawson, "The Strengthening of the Roof of New Street Station, Birmingham," and "The Reconstruction and Widening of Arpley Bridge, Warrington."

Statistical, at the ROYAL SOCIETY OF ARTS, John-st., Adelphi, W.C., 5 p.m. M. Armand Julin, "The Economic Progress of Belgium from 1880 to 1908."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. Max Poser, "High Power Photo-micrography."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. Mr. W. H. Garrison, "Our World-wide Empire."

WEDNESDAY, JANUARY 18...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. John C. Medd, "The Dutch Labour Colonies."

Meteorological, 25, Great George-street, S.W., 7.30 p.m. 1. Annual Meeting. 2. Address by the President (Mr. Henry Mellish), "The Present Position of British Climatology."

Metals, Institute of, at the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W., 10.30 a.m. Annual Meeting. 1. Professor H. C. H. Carpenter, "A New Critical Point in Copper-Zinc Alloys: Its Interpretation and Influence on their Properties," with an Appendix on "The Nature of Solid Solutions," by Mr. C. A. Edwards. 2. Engineer Rear-Admiral J. T. Corner, "Some Practical Experience with Corrosion of Metals." 3. Mr. H. J. Humphries and Professor C. A. Smith, "Some Tests on White Anti-Friction Bearing Metals." 4. Professor A. McWilliam and Mr. W. R. Barclay, "The Adhesion of Electro-Deposited Silver in Relation to the Nature of the German Silver Basis Metal." 5. Mr. G. D. Bengough, "Preliminary Report to the Corrosion Committee."

Microscopical, 20, Hanover-square, W., 8 p.m. Annual Address by the President, Professor J. A. Thomson.

Entomological, 11, Chandos-street, W., 8 p.m. Annual Meeting.

United Service Institution, Whitehall, S.W., 3 p.m. Mr. D. Owen, "The Declaration of London and Our Food Supplies."

THURSDAY, JANUARY 19...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Mr. Reginald Murray, "Banking in India."

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Linnean, Burlington House, W., 8 p.m.

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. W. H. Hurtley and W. O. Wootton, "The Interaction of Alloxan and Glycine." 2. Messrs. T. P. Hilditch and S. Smiles, "Intramolecular Rearrangement of Diphenylmethane o-sulphoxide." 3. Mr. V. H. Veley, "The Reactions between Chemical Compounds and Living Muscle Proteins." 4. Messrs. P. C. Ray and H. K. Sen, "The Decomposition Products of Tetra-methyl Ammonium Nitrite under Heat." 5. Mr. P. C. Ray, "Retardation and Acceleration in the Dissolution of Mercury in Nitric Acid in Presence of Minute Quantities of Ferric Salts and Manganese Nitrate." 6. Messrs. W. N. Haworth, W. H. Perkin and O. Wallach, "On dl- and d-Δ^2-m-menthenol (8) and dl- and d-$\Delta^{2,8(9)}$-m-menthadiene." 7. Miss B. Dobson and Dr. W. H. Perkin, "The Identity of Xanthaline with Papaveraldine." 8. Mr. R. A. Joyner, "Amalgams containing Silver and Tin." 9. Mr. R. C. Bowden, "Studies of the Constitution of Soap in Solution: the Electrical Conductivity of Sodium Stearate Solutions." 10. Messrs. J. J. Sudborough and S. H. Beard, "Additive Compounds of Phenols and Phenolic Ethers with Polynitro-aromatic Derivatives." 11. Mr. T. P. Hilditch, "The Effect of Contiguous Unsaturated Groups upon Optical Activity." 12. Mr. E. P. Perman, "The Direct Action of Radium on Ammonia." 13. Mr. S. U. Pickering, "Cupritartrates and Analogous Compounds."

Humanitarian League, Caxton Hall, Westminster, S.W., 8 p.m. Mr. James Buckland, "The Birds of our Colonies and their Preservation."

London Institution, Finsbury-circus, E.C., 6 p.m. Dr. R. D. Roberts, "The Grand Canyon of the Colorado."

Royal Institution, Albemarle-street, W., 3 p.m. The Astronomer-Royal, "Recent Progress in Astronomy." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Cinematographic Exhibition of Living Micro-organisms.

Historical, 7, South-square, Gray's Inn, W.C., 5 p.m. Miss J. Dunlop, "Early Apprenticeship in England."

Numismatic, 22, Albemarle-street, W., 6.30 p.m. Mr. G. F. Hill, "Classical Influence on the Medals of the Italian Renaissance."

Philatelic, 4, Southampton-row, W.C., 6 p.m. Display of the Pictorial Issues of New Zealand.

FRIDAY, JANUARY 20...Royal Institution, Albemarle-street, W., 9 p.m. Professor Sir James Dewar, "Chemical and Physical Change at Low Temperatures."

Mechanical Engineers, Storey's Gate, Westminster, S.W., 8 p.m. Messrs. Walter Dixon and George H. Baxter, "Modern Electrical Dock-Equipment, with Special Reference to Electrically-operated Coal-Hoists."

Civil Engineers, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. G. F. Walton, "The Design and Construction of Reinforced-Concrete Arches."

SATURDAY, JANUARY 21...Royal Institution, Albemarle-st., W., 3 p.m. Mr. Arthur Hassall, "Problems in the Career of the Great Napoleon." (Lecture I.)

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FRIDAY, JANUARY 20, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, JANUARY 23rd, 8 p.m. (Cantor Lecture.) FREDERICK WEDMORE, "Etching." (Lecture I.—"The Old Masters.")

WEDNESDAY, JANUARY 25th, 8 p.m. (Ordinary Meeting.) HORACE M. WYATT, "Motor Transport in Great Britain and the Colonies." The Hon. RICHARD CLERE PARSONS, M.A., Vice-President of the Society, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

"OWEN JONES" PRIZES FOR INDUSTRIAL DESIGN.

The Council of the Royal Society of Arts hold a sum of £400, the balance of the subscriptions to the Owen Jones Memorial Fund, presented to them by the Committee of that fund in 1876, on condition that the interest thereof be spent in prizes to "Students of Schools of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damasks, Chintzes, etc., regulated by the principles laid down by Owen Jones."

Competitions, under the terms of this Trust, have been held annually since 1878.

The next award will be made in 1911, when six prizes are offered for competition, each prize to consist of a bound copy of "The Leading Principles in Composition of Ornament of Every Period," from the "Grammar of Ornament," by Owen Jones, and the Society's Bronze Medal.

The prizes will be awarded on the Report of the Examiners in the National Competition of the Board of Education. The designs must be submitted in the usual manner to the Board of Education by April 1st, 1911. They must be marked "In competition for the Owen Jones Prizes," and must comply with the regulations of the Board of Education. The exact address to which the works should be sent will be communicated to the schools later on by the Board of Education.

No candidate who has gained one of the above prizes can again take part in the competition.

Since the institution of the above competition in 1878 six prizes have been awarded annually, except in the year 1879, when three prizes only were offered.

Of the 195 prizes which have been awarded, Macclesfield School of Art has taken 33, the first award having been made in 1881, and, with only five intervals of one year each, and one interval (1889–1892) of four years, the School of Art of that town has appeared in the prize list each year since—in several instances two awards being gained, whilst in 1909, five out of the six prizes offered were awarded to students of this school. In 1910 the number of prizes gained by them was three.

Manchester (Cavendish-street School of Art) first appeared in the list for 1879, and from 1883 till 1893 was included amongst each year's successful schools—generally with two, twice with three, and once (1886) with four prizes to its credit. In 1895 and 1896 one award in each year was gained. Then there was an interval till 1901, with one award in that year. The name did not appear again in the list of successful schools till 1907 (one prize), 1908 (two prizes), and 1910 (one prize). Manchester thus obtained in all 30 awards.

London Schools of Art have amongst them taken 30 prizes, the first award being gained in 1879, and the last one in 1910. Of the total

successes. Battersea School of Art has gained 14—its first appearance in the lists being in 1895, and the last in 1905.

The remaining London awards are distributed among the following Schools of Art:—

Bloomsbury	1
Birkbeck	1
Chelsea	3
South Kensington	5
West London	5
Westminster (St. Mary's)	1

Glasgow School of Art has received 24 awards, commencing in 1882, and it continued to appear in the list nearly every year till 1903, when the last award was gained.

Nottingham School of Art, starting in the first year of the competition (1878) with four prizes, has 14 awards to its credit—the last being in 1908.

Of the 195 awards made since the first offer of the prizes, 131 have been gained by students of Schools of Art in the above five centres.

The remaining 64 awards are divided between 28 centres in the proportions given below:—

Leeds	7	Kidderminster	2
Hertford	6	Leicester	2
Coalbrookdale	5	Salisbury	2
Canterbury	5	Barnsley	1
Carlisle	4	Derby	1
Northampton	3	Dundee	1
Scarborough	3	Durham	1
Bath	2	Glossop	1
Birmingham	2	Halifax	1
Bradford	2	Sheffield	1
Burnley	2	Shipley	1
Dover	2	Stroud	1
Dublin	2	Sunderland	1
Huddersfield	2	Warrington	1

In the year 1909, 192 competitors submitted 481 works for competition, whilst in the year 1910, 441 works from 164 competitors were considered by the Examiners.

In their report for 1910 the Examiners state: "Among the 441 works sent in for this competition were a number of designs without any merit whatever; some were so bad as to be unfit for submission in any competition, a considerable number of these coming from one school. The most successful attempts were found among the Woven, Printed, and Stencilled Fabrics. The Designs for Furniture were not thoughtfully considered from the point of view of the principles laid down by Owen Jones. There were some promising specimens of Tiles, Plaster work, and Embroidery."

PROCEEDINGS OF THE SOCIETY.

SIXTH ORDINARY MEETING.

Wednesday, January 18th, 1911; The Right Hon. Lord REAY, G.C.S.I., G.C.I.E., LL.D., in the chair.

The following candidates were proposed for election as members of the Society:—

Armsby, Henry Prentiss, Institute of Animal Nutrition, Pennsylvania State College, State College, Pennsylvania, U.S.A.

Beaumont, Frederick, 6, William-street, Lowndes-square, S.W.

Bebb, Charles H., Denny Building, Seattle, Washington, U.S.A.

Blain, Alexander W., M.D., 1105, Jefferson-avenue, Detroit, Michigan, U.S.A.

Chirol, Valentine, Queen Anne's-mansions, Westminster, S.W.

De Wardt, John Isaac, 82, Pelham-road, Gravesend.

Dowding, J. C., Chinwangtao, North China.

Eyde, Sam, Sommerrogaden 15, Christiania, Norway.

Fahy, John Thomas, A.M.I.E.E., New Zealand Railways, Wellington, New Zealand.

Finn, Herbert J., 23, Sandgate-road, Folkestone; and c/o The Modern Gallery, 61, New Bond-street, W.

Flower, Charles E., Warborough, near Wallingford, Oxon.

Hogg, Rev. William Charles, 116, East Third-street, Williamsport, Pennsylvania, U.S.A.

Kakting, Robert, c/o Messrs. O. W. Lindholm & Co., Vladivostock, Siberia.

Kean, Athelstan Joseph Alexander, P.O. Box 50, Guanajuato, Guanajuato, Mexico.

Lord, William Henry H., A.R.C.A.(Lond.), 24, The Pavement, Clapham Common, S.W.

Mackenzie, Roderick D., 9, St. Paul's Studios, Colet-gardens, West Kensington, W.

Martin, Miss Cicely Bridget, 3A, Church-road, Upper Norwood, S.E.

Menzies, Dr. F. N. Kay, 79, Davies-street, Berkeley-square, W.

Millar, Alex. H., LL.D., F.S.A.(Scot.), Rosslyn House, Clepington-road, Dundee.

Millar, F. Grahame, Tangga Batu Estate, Malacca, Straits Settlements.

Newman, Miss Florence, Garlinge, 14, Templar's-avenue, Golder's-green, N.W.

Pannett, Robert Elliott, J.P., Whitby, Yorkshire.

Peat, William Barclay, F.C.A., 11, Ironmonger-lane, E.C.

Powelson, W. V. N., 60, Wall-street, New York City, U.S.A.

Quinton, Alfred R., Westfield, Salisbury-avenue, Church End, Finchley, N.

Sunder, Donald Herbert Edmund, F.L.S., c/o Messrs. Grindlay & Co., Calcutta, India.

Tatlock, Miss H. H., 16, Park-square, Regent's-park, N.W.; and Bramfield House, Halesworth, Suffolk.

Tower, His Excellency Reginald T., C.V.O., Traveller's Club, Pall Mall, S.W.

Waley, Alexander Simon, 32, Rue Spontini Avenue du Bois de Boulogne, Paris, France.

Westervelt, William Young, 100, William-street, New York City, U.S.A.

Whittemore, Harris, Nangatuck, Connecticut, U.S.A.

Youngman, Miss A. M., R.I., Porton, Salisbury, Wilts.

The following candidates were balloted for and duly elected members of the Society:—

Andrews, Neale, Oak Works, Church-road, Hanwell.

Chamberlain, Frederick, 23, Herbert-street, West Bromwich.

Chater, Cecil William, Assoc.Inst.M.M., c/o Messrs. Mower & Co., Rangoon, Burma.

Clarke, Miss Alice Dolores, 24, The Grove, Boltons, S.W.

Hedley, Perceval Manfred Florance, The Studio, 16A, Soho-square, W.

Kiralfy, Charles I., 141, Holland-road, W.

McClean, William Newsam, 63, Evelyn-gardens, S.W.

Marlow, Thomas Gibbons, 138, Telford-avenue, S.W.

Merrick, William Altwicker, 5, Carlisle-street, Marylebone, W.

Smith, Samuel Joseph Woodham, 30, Fleet-street, E.C.

The paper read was—

THE DUTCH LABOUR COLONIES.

By John C. Medd, M.A.

Before commencing to read this paper it is fitting that I should refer to the great loss which the advocates of Labour Colonies have sustained by the death of Mr. S. H. Butcher. It was my privilege to know him intimately, and if any man can honestly say, "*Homo sum: humani nihil a me alienum puto,*" Mr. Butcher was such a man. Like every thoughtful statesman, he was constantly oppressed by the vast amount of suffering occasioned by unemployment, often preventable or capable of remedy, and notwithstanding his multifarious activities studied the question very thoroughly. He felt that temporary measures of relief, which, as a rule, perpetuate instead of eradicating the evils, avail little, and that some definite steps towards permanently lessening the volume of unemployment are essential. This led him to give his weighty support to the scheme for establishing Colonies in England upon the model of those in Holland, and he was amongst the first to sign the memorial to Mr. John Burns and Lord Carrington upon the subject last year. The fact that he and other Unionists should have done so emphasises the absolutely non-political character of the movement, while it disposes of the assertion that it has any Socialistic tendency. It is still argued in certain quarters that the creation of such Colonies as are suggested implies that the right to work is a legitimate demand, and ought to be satisfied. Even if that be the case, where is the objection? The principle of the right to work has been already admitted in much recent legislation, and is in accordance with the recommendation of the Poor Law Commission of 1834, that an offer of useful work, under conditions less eligible than those of the life of an ordinary labourer, should be placed within reach of any destitute, able-bodied man who desired to accept it. There must be something fundamentally wrong in the industrial organisation of a State when men physically fit and anxious for employment are unable to find it. To maintain that it "would necessarily impair the national efficiency and lower the national standard," is to ignore the situation as it actually presents itself. Thousands of men strong in mind and body, are, from circumstances beyond their control, out of employment; and few will deny that it is a proper function, as well as to the interest, of the State to devise means whereby they may be rescued from their enforced idleness with its inevitable deterioration and temptations.

The efforts hitherto in this country to solve the problem have not proved either an economic or an industrial success. This was the unanimous conclusion of the Poor Law Commissioners. The whole history of the past has been vitiated by a policy devoid of any well-defined object, by misguided philanthropy and by the failure to distinguish clearly between the unemployable and those genuinely in search of work. To take one instance only—the circular letters issued by the Local Government Board in 1886 and 1895 were, as was recently pointed out by Mr. Loch, a fatal step, through making the vestries and borough councils partially recognised relief authorities concurrently with the Poor Law. The local authorities rarely possessed any specific knowledge or experience to guide them; the work was badly done and at a ruinous cost. Year after year the same people, drawn mainly from the habitually unemployed,

applied for relief. Enormous sums of money have been expended without visible result—notably, by the London (Central) Unemployed Body, the members of which were admittedly not conspicuous for any business capacity, familiarity with trade conditions or knowledge of the idiosyncrasies and requirements of labourers in general. The value of their experiment at Hollesley Bay is extremely doubtful. Innumerable changes have taken place there, but the imperative necessity for prolonged and uninterrupted training at the Colony is not yet realised. The type of men usually admitted cannot be rehabilitated within two or three months; the average period of residence, however, is only about 12·2 weeks per man. Sufficient time has not elapsed for estimating the results of what is being done by the Distress Committees in London and elsewhere, since they acquired a statutory position under the Unemployed Workmen Act of 1905.

In its widest aspects the problem is purely urban. To whatever extent unemployment may be caused by periodical trade depressions, or by the fluctuating and seasonal demand for labour in certain trades—such as building, etc.—it is chiefly due to the congested condition of our cities. I may mention, incidentally, that the United States have to deal with much the same problem. The other day a letter was forwarded to me from a gentleman, who has recently been appointed a member of the State Commission in New York to inquire into and report upon the distribution of congested city population in rural districts, asking for information as to the methods adopted here. At the beginning of the last century the urban population of England was computed at 30, and the rural at 70 per cent.; in the middle of the century the percentages were about equal; at the last census 77 per cent. were urban and 23 per cent. rural, and to-day the ratio is probably at least 80 to 20 per cent. In France, on the other hand, where there is also a steady migration to urban centres, more than 45 per cent. of the total population are engaged in some branch of agriculture. The tendency to desert the countryside is world-wide in its operations. It may be checked, but it cannot be stopped, nor would it be desirable to stop it, even if it were possible, for the towns have to rely upon a regular supply of fresh and vigorous material from the villages. Every one admits the necessity of repopulating the rural districts, but it is futile to imagine that men inured to city life and of enfeebled constitution can be immediately transplanted there with any benefit to themselves or their employers. "Philanthropic ruralism can effect very little," and a year or two ago the Bureau of Agriculture at Washington published an emphatic warning against the folly of inducing men indiscriminately to revert to the land—a warning which is equally needed here. Nor can the afforestation recommendations of the Coast Erosion Commission be seriously entertained as a solution of the problem. The cost is prohibitive, and the men on whose behalf the suggestion is made are rarely of a physique capable of undertaking the rough work of clearing and digging the ground, apart from their lack of the necessary skill to plant a single tree. Such has been almost the universal experience of those who have attempted to utilise labour of this kind in even the preliminary stages of afforestation.

In formulating any scheme the aim should be to replace temporary palliatives by systematic treatment, and carefully to differentiate between the varying classes of the unemployed. They may be roughly placed in three categories:—(1) Those who from physical infirmity or age are unable to work. For these the contemplated insurance against sickness and invalidity combined with old-age pensions will ultimately provide, but it must be remembered that a considerable proportion of men and women in this category have already fallen out of the ranks in middle life or earlier, and for them the time of insurance is past. What is primarily required is a strong Central Public Assistance "Division," as recommended by the Poor Law Commissioners, representative of and partially directing the Public Assistance authorities in counties and county boroughs. With them all forms of voluntary aid should be connected. The Charity Commissioners would need some reorganisation, and should be attached to the Local Government Board. Under schemes passed by the Commission there would be Voluntary Aid Councils in the counties and county boroughs, and Voluntary Aid Committees. This utilisation of the aid and experience of those who have hitherto been administering charities, together with an Elberfeld system modified to meet English conditions, is indispensable to prevent overlapping and to ensure that effective provision shall be made. (2) Those who, for economic or industrial reasons, cannot find employment; and (3) those who are unemployable owing to defects in character. To-night we are concerned with the unemployed rather than with the unemployable, but it is necessary

briefly to refer to the latter in the hope of removing the false impression which still exists that those who press for the introduction of the Dutch system for the benefit of the former are advocating something which has proved unsuccessful in other countries. In reality the Colonies in Holland differ *toto cœlo* from those established elsewhere. Since the world began, every State has been vexed by the presence of the unemployable, and the social economist is justified in saying that in their case the problem is mainly a moral one, but the question cannot be thus summarily dismissed. *Nemo repente fuit turpissimus.* In many cases the man is the victim of circumstances, and of the environment in which he is compelled to live. He is, especially in childhood and adolescence, like an animal at pasture; from the things which he sees and hears about him he assimilates little by little the good or evil which they embody, and which becomes part and parcel of himself. To build up the self-respecting citizen it is imperative for the State to improve the man's surroundings, and to remove the obstacles which render the good life practically unattainable amidst the squalor of the slums. The magnitude of the evils by which we are confronted is due to the past iniquitous attitude of *laissez-faire*, but, whether the failures are attributable to our neglect or not, we are called upon to deal with them for the welfare of society, and the methods for doing so are as old as Ancient Greece. Plato realised that expulsion is the only alternative to reversion to an ordered life. He recognised that a man may become so entirely disordered and wrecked as to be incapable of revival, and should be sent to what was euphemistically termed a "Colony." To such a Colony the majority of those in Belgium, Germany and Switzerland closely correspond.

Belgium.—In Belgium there are two types of Colony, *Dépôts de Mendicité* and *Maisons de Refuge.* The latter are intended for the aged and infirm, or for men temporarily unemployed, and resemble the English workhouse. The former are for professional beggars or vagrants, and for persons convicted of various crimes. The principal Dépôt is at Merxplas, where the inmates number about 5,000. Three years is the maximum period of detention, but the average time is only about sixteen months. Two great defects in the organisation are the lack of any classification of the inmates, and the absence of any religious influence. In the opinion of the Director little reformation is to be hoped for from the treatment there. "Once a colonist, always a colonist," seems to be the ultimate verdict. The number of entries tends to increase yearly; recently the population amounted to 5,110, of whom 5·9 per cent. only were there for the first time, while 72 per cent. had returned at least four times. It is true that the compulsory Labour Colonies have done much towards clearing the country of beggars and tramps, but as regards any systematic effort to solve the "unemployed" problem, Belgium can teach us little. In his valuable work on "Land and Labour: Lessons from Belgium," Mr. Rowntree points out that probably the most important factor in lessening the suffering due to unemployment in that country is the economic stability given to a large proportion of working-men by the fact that they are enabled to live in the country through the extraordinary cheapness of workmen's railway tickets. They generally have a plot of land, and, if they are seasonal workers, rely upon the period of unemployment for digging and manuring the ground. For such men unemployment is not synonymous with abject poverty, as is often the case in England. Relief works for the unemployed are only provided on a very small scale, but an interesting experiment has been made by a few of the Trade Unions in establishing workshops—*Ateliers de Chômage*—in which their unemployed members may work at their own trades. One of the largest of these is that of the cigar-makers at Ghent, which was started some thirty years ago.

Germany.—In Germany there are thirty-four Labour Colonies, the first of which was established in Westphalia in 1882, under the management of a charitable association—the Labour Colony Central Board—providing accommodation for 4,000 persons. Admission is voluntary, there is no compulsion to remain, although apparently some attempt is made to induce the men to stay for not less than two months. Under these conditions it is idle to expect any reformatory influence to be exercised. The inmates are largely recruited from the criminal classes, who by their presence drive away the honest workman, whose chance of subsequent employment might be seriously diminished from his having had recourse to such an institution. The Colony at Schäferhof, near Hamburg, is somewhat differently constituted. Its Director states that a genuine effort is made to persuade the inmates to stay there long enough to make it possible to effect a substantial change in their moral and industrial character, and that "reclamation is effected in the case of about

10 per cent. of the inmates." For habitual vagrants there are twenty-four *Arbeitshäuser*, which, to some extent, resemble the original Houses of Correction here and the forced Labour Farms of Switzerland. Under Sections 361 and 362 of the Imperial Code, vagrants, beggars, and those who cause their children to beg; those who through their own discreditable conduct have to apply for relief; and anyone who, after losing his lodging, fails to procure another within a certain time, may be committed for detention in an *Arbeitshaus* after serving a term of imprisonment. The average period of detention is about a year. The *Arbeitshäuser*, which can accommodate about 15,000 people, are controlled by the authorities of the Province, being in fact a kind of prison under strict military discipline. During recent years there has been a marked decrease in the number of the inmates, and vagrancy is certainly diminishing. Professor Mavor, in the Board of Trade Report of 1893, states that all the evidence with regard to Colonies of the type of Merxplas is against the supposition that such institutions are reformatory; "they form merely a receptacle for those who, if they were free, would prey upon society and render means for relieving the deserving poor wholly futile." With the *Herbergen*, a sort of model lodging-house for destitute wayfarers, and the *Verplegungs-Stationen* (relief stations) this paper is not concerned.

Switzerland.—Switzerland has three voluntary Labour Colonies, managed by philanthropic societies, where the men must consent to remain for one or two months. In nearly every Canton there is a compulsory Colony or forced Labour Farm, to which beggars may be committed for detention for a period of from three months to two years. As a rule these Colonies are small; at Witzwyl, the largest, the number of inmates does not exceed 200. The farms are worked economically, and there are workshops at which various industries are carried on, but, as at Merxplas, no trades appear to be taught. At Witzwyl the staff number forty-five, or one to every five inmates. Mr. Preston Thomas reported to the Departmental Committee on Vagrancy, 1906, that the men there did really work hard, and that the results of their work were visible on every hand. As he truly observed, "When a man sees the products of his labour, which have grown up before his eyes, he is induced to exert himself, and is stimulated in a fashion which contrasts with the leaden monotony of such occupations as stone-breaking and corn-grinding." On discharge, a man is provided for either by (*a*) employment as a paid labourer at the Colony; (*b*) the action of a discharged prisoners' aid society; or (*c*) admission into a voluntary farm. The system pursued in Switzerland seems to have met with more success than that in either Belgium or Germany, but the results in each case are such as to justify Mr. Loch in saying that one can expect no large or general transformation of character from the adoption of a similar system.

Holland.—The Dutch Free Labour Colonies at Frederiksoord, Wilhelmsoord, Wilhelminasoord and Boschoord, which are quite distinct from the Penal Colonies now controlled by the Government, suggest, *mutatis mutandis*, the best method of solving the problem of unemployment in so far as it relates to those unemployed from no moral or physical defect. They are under the direction of the Society of Benevolence (*de Maatschappij van Weldadigheid*), which was founded by General van der Bosch in 1818, owing to the distress occasioned by the famine of that year, and which took for its motto, "Help the Poor and improve the Land." The entire management is in the hands of a single administration, with headquarters at Frederiksoord. Local committees have been formed throughout Holland, whose first duty is to enlist members for the society, the minimum subscription being 3*s.* 6*d.* per annum. After deducting expenses incurred by a local committee, the balance is transmitted to the Director at Frederiksoord and credited to that committee. As soon as this amounts to £141 3*s.* 4*d.*, the general committee, which meets once a year, may entitle the committee to send one family to the Colony after consideration of its fitness. The aim is to assist respectable persons who cannot earn a livelihood in the towns. Children below the age of twelve, who are being maintained in various municipal institutions, are admitted and boarded out with suitable families. A special superintendent is appointed for their protection. The average number of boarded-out children at Frederiksoord is about 250, of whom about twenty-five are annually placed in situations outside the Colony. In the opinion of Heer Boissevain, the Director, the work of the society with regard to both the boarded-out children and those of the colonists has proved a great success.

Organisation of the Colonies.—The total estate of the society comprises some 10,000 acres, formerly heath and sand, which has now been brought into a condition of high fertility, and the

average number of colonists, with their families, is 3,000. On arrival at Frederiksoord each family is provided with a separate cottage and garden. Their immediate wants are supplied, not as a gift, but by way of advances to be repaid by instalments. A sheep is given, which can be pastured on the society's land for a small weekly sum. A certain sense of ownership and responsibility is thus imparted from the very beginning. Those who are able to work are at once engaged in various agricultural and industrial occupations, according to their capacity. In addition to agriculture, the following industries are carried on:—Mat-making, smithy work, tailoring, carpentry, bricklaying, basket and furniture making, and forestry. The equipment for each of these is admirable. Wages are paid upon the scale common to the neighbourhood. From these are deducted the instalments on the debt incurred on arrival, house-rent not exceeding 4*d*. a week, one cent., or less than a farthing, as infirmary fee for each person, about a penny for the clothing fund, and 10 per cent. of the gross earnings as a reserve for the family emergency fund. The endeavour throughout is to restore the individual, develop his industrial potentialities, and encourage habits of thrift. It is realised that this cannot be effected in a few weeks or months, and two years of training and probation are insisted upon. If at the expiration of that time a man shows no inclination or capacity to work, he must leave. If, on the other hand, he shows himself to be reliable and industrious, he is eligible for promotion to the position of a "free farmer," and, if there be a vacancy, is put on a small farm of about 6½ acres, the rent of which varies with the condition and quality of the soil, ranging from £2 18*s*. to £6 5*s*. a year. He then receives seed and stock on loan—generally a cow valued at £10, and seed to the value of £4 3*s*. 4*d*. This capital sum has to be repaid with interest at the rate of 12*s*. per annum, and about £2 3*s*. 4*d*. worth of manure must be put on the land each year. The "free farmers" have now a co-operative dairy and a co-operative society for supplying themselves with fodder.

Education.—In some respects the most valuable and permanent of the society's efforts is the extreme care to ensure that the children of the colonists shall be thoroughly educated. In fact, the education provided within the area of the Colonies precisely illustrates the education which ought to be accessible to every child in every country. At Frederiksoord, for example, there are five public primary schools. Boys, on leaving them, must attend a continuation class for two years, and girls a domestic science class until their sixteenth year. The lads are trained for various trades, the railway, post or telegraph services, the army (there is a flourishing lads' brigade), the navy, or as farmers or gardeners. Intermediate schools of horticulture, agriculture and forestry have been established, each of which has an annual subsidy from the State. The horticultural school, which is attended by lads of fifteen for three years, and receives a subsidy of £400 per annum, has an extensive and well-kept garden of 12 acres, cultivated entirely by the pupils. It is not confined to the sons of colonists, and it is gratifying to know that no ill-feeling exists between the children of independent parents and those of the inmates. Theoretical instruction is given at the agricultural school during two winters, and practical work is done on one of the society's farms in the summer. The school of forestry, with a course of two years, has a large nursery and some 60 acres for clearing.

Criticisms.—The proper function of a Labour Colony is to act as a bridge for the unemployed, and to pass on a succession of trained and rehabilitated men. No human institution, however, is perfect, and this function the Dutch Colonies have, as a rule, failed to perform. Few of the men display the slightest inclination to exchange their protected position in the Colonies for one outside. But to this criticism the Dutch are entitled to reply that they have for nearly a century been providing permanent homes and employment for otherwise destitute men, and have to that extent relieved the congestion of the towns, while at the same time they have rescued the children of the colonists from the degradation of the streets, educating them and training them into useful citizens. To have exercised this civilising and redemptive influence over so long a period is no mean achievement. It must be recognised, too, that poor families living in towns frequently become accustomed to receive relief from their childhood, and parents encourage their children to beg. They are exploited in every way, and, as a result, numbers of them are morally and physically ruined. The same municipalities which have assisted the parents will afterwards have to support the children. From every point of view it is desirable to remove such families from the towns and put them to some useful employment, ensuring meanwhile the future of the children.

In the extremely meagre account of the

Colonies in the Report of the Poor Law Commissioners, a point is made by the Committee which visited them of the fact that no townsman could be found amongst the "free farmers." Now, it is open to very serious doubt whether men, debilitated and demoralised by town life, can ever become successful agriculturists. That, however, is not the type of man for whom the proposed Colonies are designed.

It is further objected on economic grounds that the Colonies are not self-supporting, but the deficiency that has to be annually met from outside sources is trivial compared with what the municipalities would have to pay for the relief of such families, or for their maintenance in workhouses, asylums or prisons.

Advantages of the System.—Briefly, the merits of the Dutch system may be thus summarised:—

1. That a man is settled *with his family* on the land, and that a cottage is provided for him, for which rent is paid.

2. That the men are employed at once on the farms connected with the Colonies or in other occupations.

3. That temporary advances on loan are made for whatever may be necessary to furnish the home and to satisfy the immediate wants of the family, and that these advances are repaid by deductions from the weekly wages which are paid for the labour of the family according to the scale prevailing in the vicinity of the Colonies.

4. That after two years a labourer of industrious habits may be promoted to the position of a small farmer, the Colony rendering him every assistance in the development of his land.

5. That all children of the colonists have excellent primary education, are compelled to attend continuation schools, and receive technical instruction in agriculture, horticulture, forestry, or whatever industry they may prefer.

6. That, although no special means are taken to bring the colonists under moral or religious influence, a religious spirit, entirely free from sectarian prejudice, pervades the whole scheme. Frederiksoord, for instance, possesses one Roman Catholic and two Protestant churches.

Application to England.—In advocating the introduction into England of something analogous to the Dutch system, it must be remembered that the Vagrancy Committee of 1906, and both the Majority and Minority Reports of the Poor Law Commissioners recommended the establishment of Labour Colonies. That some practicable scheme for restoring the able-bodied unemployed of good character to remunerative work is imperatively needed nobody denies. Even in years when trade is flourishing the minimum of unemployment is tending to rise. This was admitted by Sir H. Llewellyn Smith in his speech foreshadowing a scheme of national insurance. When an effective scheme of insurance against unemployment comes into operation, the evils may be mitigated; no benefit, however, can accrue therefrom to those who are to-day in want of work, and we cannot afford to wait.

Undoubtedly the Labour Exchanges are bringing the unemployed into touch with places where there is a demand for them, but the demand can never under existing circumstances equal the supply. No surprise need be felt that Mr. John Burns should still hesitate to commit himself to any proposals for establishing a Colony of the type suggested. The experience of Labour Colonies in this country has not been such as to inspire confidence, but the causes of their failure, comparative or otherwise, are not far to seek, although it would be invidious to enlarge upon them here. The improvement of Dutch methods and their adaptation to English requirements ought to present little difficulty, and it has been urged that the Government should without delay establish at least one Colony upon the following lines:—

1. The unemployed for whom the Colony is intended, must be carefully selected, preferably country-bred or accustomed to the use of a spade, and must contract to remain there for two years. If during that period they prove unfit for the work, or in any way unsatisfactory, they should be removed to a Colony of a more or less penal character, and in no case be abandoned to their own resources.

2. The men to be settled on the Colony ought to be accompanied by their families and housed in cottages which should not cost more than about £140 each.

3. Arrangements as to loans of money and stock might follow the Dutch plan, while wages would be paid at the current rate of the locality.

4. Provision for the efficient education of the children, as in Holland, is essential.

5. During the two years' probation the men should receive instruction upon soils; manuring; the management of stock; the choice and selection of seeds; vegetable and fruit culture; pig, poultry and bee keeping; the grading, packing and marketing of produce; and especially in the principles and practice of co-operative production and distribution. In addition to the land subdivided amongst the

colonists, there should be experimental or demonstration plots, together with a farm and a garden to illustrate the best and most scientific methods of cultivation.

6. At the expiration of the two years the men ought to be qualified to join an independent and co-operative association of small-holders, as contemplated by the Small Holdings Act and encouraged by the Board of Agriculture. Such associations might be formed in the neighbourhood of each Colony, but to facilitate their organisation and development Agricultural Credit Banks, which have assisted the Irish farmer so materially, should be promoted on the model of the Raffeisen Banks to be found in many Continental countries. In this latter respect the Board of Agriculture might safely be relied upon for sympathy and support.

There could hardly be a more beneficial object to which a portion of the Development Grant might be applied than in the establishment of such a Colony. Land suitable to the purpose abounds, and, if the initial experiment succeeded, each county council might establish one within its area for a hundred inmates or whatever number local needs required, and organise it in accordance with local circumstances. Improve the land by the man and the man by the land. That is the fundamental principle. No scheme yet before the public seems so well calculated to diminish the volume of unemployment, to restore the balance between rural and urban population, and to secure a priceless benefit to the nation by repopulating the rural districts with a race of contented, healthy and prosperous cultivators of the soil.

DISCUSSION.

The Chairman, in opening the discussion, cordially welcomed His Excellency the Netherlands Minister, who was present. With regard to the right to work, he said he should prefer himself to use the word duty. Mr. Medd had said that there were probably more unemployed than work for them to do, but in Lancashire at this moment he believed there was more demand for labour than labourers to meet the demand. In Scotland there was occasionally difficulty in finding unskilled labour to repair roads. In Switzerland a referendum was taken with regard to the principle of the right to work, with the result that on June 3rd, 1894, 75,880 voted for the principle and 308,289 against, and, what was very rare, the whole of the Cantons opposed the principle. The argument seemed to have been the difficulty or impossibility of putting it into practice under a non-socialistic organisation of society; and on the other hand that if Socialism prevailed there would be no longer any need for the right to work. The great Socialist Liebknecht in Germany only praised it as a demonstration, and Bebel spoke of it very slightingly. Mr. Medd had rightly laid stress on the importance of the classification of the unemployed, and of putting on to the land only those who were fit to perform agricultural work. The cry of "Back to the land" was delusive. He had been told by a farmer in Scotland that if one of his men spent a year in a town, on his return to the farm he was unfit for agricultural work. It was necessary to be careful not to draft into the country those who lacked the necessary qualifications for rural life. In France, military service had made the men drawn from the land in many cases very unwilling to go back. The endeavour should be to keep the present population already on the land, and to take care that their children were so educated as to look on country life as offering them a congenial sphere of activity. The main feature of the Dutch system was that the people sent to the Colonies were sent there not by the Government but by voluntary effort; the committees were all self-supporting and the governors of the Society of Benevolence men of the highest standing. Mr. Medd had urged that the British Government should without delay establish a Colony on certain lines, but he would prefer strictly to adhere to the Dutch lines, the Colony being managed by a private association, which of course should be in close relation with such Government agencies as existed for the unemployed. He agreed that it was important to correlate voluntary agencies with Government agencies, and he believed that in the Bill which had been introduced in Holland for the reform of the Poor Law one of the principles was a closer connection between the State and the voluntary associations. He thought one of the most beneficial societies in England was Dr. Barnardo's Homes. They had been of the greatest benefit both to the children sent to Canada and to the Canadian farmers, who asked that the boys should be sent to them young, before they had had any experience of city life, so that they might be inured to the rather rough life in the west of Canada. Mr. Medd suggested that men, after having spent two years in the Colonies, should become small holders. If small holdings were to succeed, it was very desirable to locate them in numbers and not scatter the holdings all over the country, so that there might be co-operation and a system of credit banks. He agreed with Mr. Medd that those who showed themselves during the probation period to be unfit for agricultural labour should be at once weeded out, because obviously at first there would be more people applying than could be dealt with by the Colony. They could therefore admit in the first instance the most fit. It seemed to him that the all-important point of the Dutch plan was that a man was immediately put in a position of some responsibility and made to feel that he was trusted; he was put in a position where by industry and self-help he gained

a feeling of self-respect, the loss of which was at the root of so much of the misery in this country. He invited those who had not seen the Dutch Colonies to pay them a visit. The horticultural school was an important feature. The status of the colonists was shown by the fact that those who came for an independent training mixed with the sons of the colonists without any feeling of class restriction. He trusted that the Dutch experiment would be carried out here exactly on the Dutch lines by means of voluntary effort, with a grant from the Development Fund and inspection by the Board of Agriculture. Mr. Medd's paper was a valuable contribution to our knowledge of a very difficult problem.

Mr. T. EDMUND HARVEY, M.P., expressed his gratitude to the author for the suggestions contained in the paper, though he could not quite agree with the criticism of the Central Unemployed Body. As a former member of that body, he thought he might say that, although the members of it were dissatisfied with the work, yet a great measure of the failure was due to the imperfections of the Act, which was only a temporary one set up as an experiment. It had done sufficient, however, to show some of the lines along which the problem had to be attacked. It should be remembered that the Hollesley Bay Colony was at first intended as a means of placing upon the land in small holdings, as co-operative farmers if possible, the most successful of the colonists, but, owing to the restrictions of the Act and the views of the Local Government Board, that was impossible, and therefore the experiment was bound, to some extent, to be a failure. There were no means of dealing with the men who were unwilling to work other than sending them away, so that the penalty fell upon the family. If there was a system of detention Colonies, by which a man could be kept until he had received the necessary moral and physical discipline to fit him for a useful place in life, then he thought the Colony would have greater possibilities. The Act was really a step forward, marking an increased sense of responsibility in the nation for the wastage of our industrial system. He differed somewhat from the Chairman in connection with the relation to the State of any future experiment, hoping it was possible to combine the Dutch experience with something better. The Majority and Minority Reports were in substantial agreement in recommending a system of Colonies with detention Colonies in the background, and he thought no great mistake could be made in adopting their recommendation. He hoped to see a system established in the near future giving free play to voluntary enterprise and having the necessary help of the State, with a detention Colony for cases that were beyond the help of the voluntary Colony. Then the help of the great religious agencies, the Church Army, the Salvation Army, the Christian Social Union, and other organisations, could be called in. It had to be recognised that the present Poor Law system had failed in dealing with the problem of the able-bodied, although the intention of the Poor Law was admirable. The Government should be called upon not simply to be content with renewing from year to year an Act which was a necessary and useful experiment in its time, but to go forward with legislation which was absolutely necessary, and which was demanded alike by schools of thought so different as those represented in the Majority and Minority Reports.

Mr. T. CUTTER said he had been struck by the absence of any remark as to the wages paid in the Labour Colonies. He thought it unfair to criticise the Central Unemployed Body without considering the matter from the English standpoint. The Hollesley Bay Committee had to deal with men accustomed to urban work sent to the Colony to learn agriculture, and he did not think a more hopeless project could exist. On an independent visit to Hollesley Bay he found an Essex ploughman, followed by seven or eight colonists, ploughing a field. They said they were learning to plough. He asked them on what conditions they were there, and one man, who came from Birmingham, said his family were being paid 9*s.* a week and he himself was receiving about 10*s.* a week, which brought the total wages up to 19*s.* His hours were less than those of the ploughman and he had the Saturday afternoon off, which the ploughman did not. The ploughman said he received 14*s.* a week, out of which he paid his own house rent and maintained his wife and family. Therefore men totally unsuited for agricultural work were receiving higher wages than the skilled agricultural labourer on the spot. He asked one of the colonists whether, if he learnt to do the work, he would be prepared to stay in the district at 14*s.* a week, and he said he would not. Men accustomed to big cities, with its cheap music-hall pleasures, were not very willing to go into rural districts at all. His experience was that the Unemployed Committee were dealing with a hopeless problem in attempting to make an unemployed man from the Metropolis into a farm labourer.

The Rev. J. H. ANDERSON (Chairman of the London (Central) Unemployed Body) said he had had the bitter experience of finding that it was a very hard thing to preach the duty to work when there was not enough work to go round. It was no use telling people they had a right to work in an industrial system which did not give men the opportunity of performing the elementary duty of maintaining themselves and their families. As Hollesley Bay had been mentioned, he should like to say—and he believed the Body he represented agreed—that the defect of Hollesley Bay was that it had never been allowed the proper outlet for men which training there might have been expected to fit them for. After a period, all too short, of sixteen weeks, men went back again to the place from which they came. That, however, was not the fault of the Unemployed Body or of the Local Government Board. Whenever a selected body of men had been put forward to the Local Government

Board for permission to continue their training, the Local Government Board had never refused, and there were men who had been there for years. After a year a man was located in a cottage adjacent to the estate, and became an ordinary labourer on the estate. The trend of opinion on the Central Body was in accordance with the principle advocated by the author. The Board of Agriculture had been already approached with the view to enabling some of the two-year trained men to obtain small holdings, and the London County Council had been asked to put into action the powers they had under the Allotments and Small Holdings Act; but he regretted to say that up to the present time very scant encouragement had been received for those laudable enterprises advocated by the author and already put into practice by the Central Unemployed Body. With regard to financial conditions, when a country labourer was asked what he received, he would mention his weekly wages of 14*s*., but would say nothing of his harvest money, or the amenities of his cottage, or of the pigs and the hens, and all the rest of it. Perhaps it could not be said that his wages would amount to that actually paid on the Hollesley Bay estate, but the wages paid to the colonists had to be paid, not on the basis of what was paid in the immediate neighbourhood, but on the basis of the necessities of family life in the Metropolis. The men left behind in the Metropolis their wives and families, who were paying rents very different from the rents in Suffolk. The total cost of a family only amounted on the average to £1 6*s*. 6*d*. per week, and that compared very favourably with the amount paid by analogous bodies. It had been stated that the amount paid was 19*s*. per week, but the highest sum in the scale at Hollesley Bay was 17*s*. 6*d*. It had not been possible to place trained men on small holdings, but they had been placed with farmers who were glad to have men who had had some training in the Colony. During the last year thirty-five such men had been placed, with regard to thirty of whom very satisfactory reports had been received. Of the other five, two were doing well in work other than agricultural, and only three had proved failures.

Mr. D. F. Schloss said it had been his duty to visit all the Colonies mentioned by the author, some of them more than once, either for the Board of Trade or for the Poor Law Commission. He understood the author's argument to be that all the Labour Colonies that had been tried had proved a failure. He agreed with all the facts the author had mentioned in connection with the imperfections or failure of the Colonies, but whether they formed a sufficient basis for the proposal to start a series of Labour Colonies in this country he would rather not venture to say. But as something had been said about the remarkable results of the Dutch Labour Colonies, and as the author had not had time to go into those results except to say that they were not satisfactory, he should like to give a few exact figures. Those figures would not prove the success of the Dutch Labour Colonies, because those Colonies were not successful in solving the problem which was under discussion that evening. What the Dutch Labour Colonies did for the children was beyond all praise and deserving of imitation, but they did not succeed with respect to adults, and he thought it would be very wonderful if they did. The measure of their success was the number of men whom they raised to the position of independence, the men who from the position of labourers in the Colony were advanced to that of free farmers. In 1889 five new families came, and five were promoted to free farmers, and the figures were much the same for the next few years. In 1893, three new families came, and one man was elevated to a free farmer. In 1894 none came, and one was elevated, while from the year 1895 to 1902 the figures for those who came were respectively two, one, one, four, two, none, one, and none, and during those years not one family was elevated to the position of free farmer. He had no figures with regard to the years 1903–4, but in 1905–7 there were fourteen or fifteen new families and between ten and twelve free farmers. When he was there in 1908 there were 100 colonists and 250 free farmers. If the families were promoted after a period of two or three years, instead of being 100 labourers there, there would have been only about a dozen, and therefore the aim of the Colony did not seem to be fulfilled. There were three things that appeared to account for that want of success. In the first place, he was told by the Director that very little discrimination was exercised in admitting new families, people being chosen who were destitute and had large families. When the Poor Law Commissioners were going round, and could not find a single person from a town who had been promoted to be a free farmer, it was explained that they were persons debilitated by town life. Another remarkable thing was the total absence of anything like systematic agricultural training, and there was also an absence of systematic religious influence. The Poor Law Commissioners asked the Director whether there was any missioner or any attempt to influence the people from a moral or religious point of view, and he said there was not. There were churches with a capital of eighty millions, and the total sum for religious services appearing in their budget was £38 a year. He thought it was futile to discuss the purely economic side of the question from the point of view of the balance-sheet, which he had never been able to understand. There was nothing charged for rent, and only a very small sum charged for interest. One of the best tests of the success of such a large Colony of 10,000 acres was how far they could utilise the means in their possession, and at the present moment they had 100 farms which they let because they could not fill them. The Dutch Labour Colonies therefore were not entirely successful, but whether that was a reason for adopting the Dutch system in this country he was not prepared to say. He did not thoroughly understand the

exact plan proposed by the author or the kind of men who were to go to the Colony. They were to be taught an enormous number of very difficult things in two years, and, if they did not succeed in learning them, it appeared they were to be removed to a Colony of a more or less penal character. It would seem that a man would be brought before a magistrate on the charge that he had failed to learn agriculture in two years, and the sentence was to be indefinite detention!

Mr. J. C. Medd, in reply, remarked that what Mr. Schloss said was very interesting, but he was afraid Mr. Schloss did not quite realise that the suggested Colony in England would be entirely free from the defects which had caused the comparative failure of the Colonies in Holland. The principle upon which the Colony would be organised in England was that no man would be allowed to remain in it beyond a period of two years. The criticism passed in the paper upon the Dutch Colonies was that they allowed the men to remain practically for ever upon the estate, and that, he thought, was the chief cause why they had failed. What he wanted to impress upon Mr. John Burns was not to reproduce in England anything in the nature of an exact copy of a Dutch Colony, but to adopt the principles on which the Colonies in Holland originated: the removal of the whole family from the contaminating influence of the town, and the essential importance of thorough education for the children. Even if the Dutch Colonies had been prevented by accident from rehabilitating and sending forth into the world again the head of the family, they had at any rate succeeded in educating and forming a group of most useful citizens for nearly a century. It was easy to criticise any institution, but in the present case it was not the institution that was to be imitated but the principles which governed it; and until someone presented an outline of a Colony with more enlightened principles than those which actuated the founders of the Dutch Colonies, he should venture to believe that those were the soundest principles. If he had appeared to criticise the action of the Central Unemployed Body it was not his intention to do so, because he knew perfectly well the limitations under which they had been compelled to act. He merely referred to their action because he believed that the failure, comparative or otherwise, of the Colonies in England had been due to ignoring the two essential facts, namely, taking the whole family and insisting on the man remaining for more than two or three years. With regard to the wages question, what Mr. Anderson had said was quite correct; the weekly wage of an agricultural labourer was very little indication of his annual earnings. It was quite erroneous to compare the wages which a man fully employed in London could earn with the wages of an agricultural labourer. The case under consideration was that of the unemployed, the man who started from zero, who, if he had a chance of earning 19*s.* a week was obviously in a much better position than he would be in London earning nothing. He fully acknowledged the force of the criticism with regard to the free farmers, and provided for it in the suggested organisation. The whole paper was based on the assumption that there were men capable of doing good work, but who, from circumstances beyond their control, were unable to find that work. If Mr. Schloss believed there were no such men in England he could only say that he differed from him.

In conclusion he thanked Lord Reay for his kindness in taking the chair that evening, and joined with him in thanking his Excellency, the Minister for the Netherlands, for being present to listen to the paper and the discussion.

On the motion of the Chairman a vote of thanks was accorded to the author for his paper, and the meeting terminated.

SAGO-MAKING IN CERAM.

Ceram—one of the Moluccas—is probably the metropolis of native sago-manufacture in that part of the world. In the early part of 1909 there were two of us on a zoological expedition in the

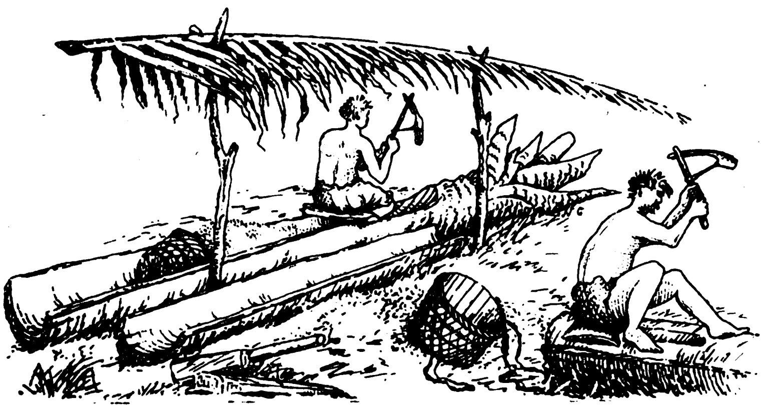
Sago Palms, Old and Young, in Swamp.

Dutch East Indies, and our work kept us continually amongst the sago-swamps during the four months we spent at Piroe, a small village in western Ceram, and the nearest port to Amboyna or Ambon, as it is called by the Dutch and Malays. The only white men in Piroe (there are probably but half-a-dozen in the whole island) were the Resident, two Dutch soldiers, and a missionary. A small native war—difficult and desultory forest-fighting—was

in progress against certain Ceramese tribes; and we lived in a compound occupied by about twenty Amboynese soldiers, the forest closing us in on every side but towards the sea. The whole of this large island is practically covered with forest, and the greater area is very mountainous; but there is much low-lying coastal land, and there the sago-palm (*Metroxylon Sagu* of botanists, a species which only occurs in the East Indian Archipelago) grows luxuriantly. It is turned to almost as many uses as the bamboo, for besides furnishing sago, its leaf-fronds provide "attap" or thatch; the whole mid-ribs of the leaves, termed "gaba-gaba," make rafters and posts for houses, and when split are used for floors and walls; split into smaller strips they make excellent cord.

Many people seem to think that coco-nuts and other fruits growing in these wild countries may be plucked by anybody who wants them; but all such trees, even in the depths of the forest, are private property, and the sago-palm is no exception. Every palm is owned either privately or by villages, or the treacle. On this we practically lived whilst at Piroe.

Natives come to Ceram, which is very thinly populated, from Ambon and many other islands far and near; procure a Government licence to cut so many trees, and live and work in a sago-swamp till they have converted the trees into sago, sailing for home with the finished product. The trunk of the palm often attains forty-five feet in length to where the leaf-fronds spring, and a diameter of two feet; but thirty feet to the crown is a fair average, and even then the trunk will usually measure two feet in diameter. Such trees at Piroe cost, standing, two to three guilders each (about four shillings), and one man can fell, extract the pith, build the washing apparatus, and prepare the sago in about fifteen days, if he works hard; but the Malay is not fond of hard work or indeed any work, and in these islands he can live almost without labour. From one sago-palm he can obtain a supply of food which, varied a little with fish and vegetables, will last him many months. The natives distin-



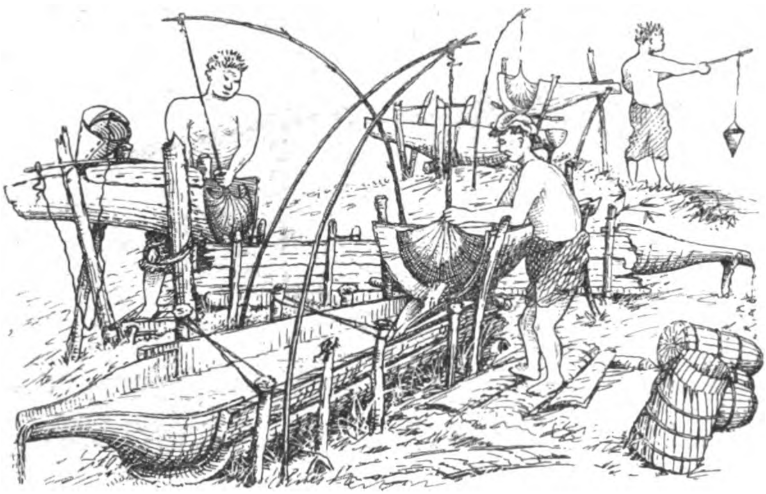
Cutting out the Pith.

Dutch Government; but the trees and prepared sago are sold so cheaply that probably no death from starvation is ever heard of in the Dutch East Indies, for the sago from Ceram is sent all over the islands.

Now the sago of the shops in civilised countries is familiar to everyone, but it is doubtful if many people would recognise the native article as sago, or sagu, to call it by its native name—sargoo as the Malay pronounces it. Neither appearance nor taste have much in common with the sago one buys in England. The brick or cake sago we did not appreciate, though the Malay children gnaw it with great satisfaction, and it is so hard and tough that it lasts for hours and requires splendid teeth—and probably a first-class digestion—to tackle it; a cake looks and feels very much like gray or pinky-white sawdust, strongly compressed. When boiled, however, it is of a darkish-brown colour and gelatinous, and very nice when eaten with native sugar syrup, made from another species of palm and resembling thin, burnt guish four varieties of palm, viz.: *Sagu duri* and *S. makanaru*, which are both thorny, the young trees being armed on trunk and leaf-sheaths with immense, strong slender spines, sharp as needles; and *S. tuni* and *S. mollea*, which are thornless. The amount of sago produced from these palms varies from about ten packages of finished sago from *S. makanaru* to eighteen or twenty from the other trees, each package weighing about twenty-five catties (say eighty pounds). The life of a palm is said to be about ten years before it is ready for felling; this is done as soon as the flower-spike appears, and the tree is always cut down before it is in full flower, otherwise much of the pith is spoilt.

The palm is first of all chopped down close to the ground with parangs, or native swords, and the leaf-stalks lopped off; a transverse cut is made half-way through the trunk about its mid-length, and wooden wedges driven with a heavy wooden mallet in a longitudinal line from both sides, thus splitting off the upper part, which is rolled over

alongside. Each half-trunk now has the pith exposed; strong and fibrous and intimately mixed with the starchy substance, and of a rusty or reddish-white; this is gradually chipped away with a bamboo adze, the operator meanwhile sitting astride the trunk at one end on a piece of leaf-sheath, and slowly cutting his way to the other end, whilst the broken-down pith—like coarse pinky-white sawdust—accumulates behind him in the hollowed-out trunk; for the rind is tough and hard, about an inch thick, and forms an excellent trough. The pith is then thrown into palm-leaf baskets or dumped on the ground; the hollowed half-trunk is fixed up with a few pieces of leaf-stem underneath and stakes along each side, the latter usually lashed together with rattan across the trough, the sides of which are often heightened by the addition of a split piece of trunk each side. Two large leaf-sheaths are now cut to form the basket of pith into the strainer-trough along with a few buckets of water from the nearest pool or stream—one has not far to wander for water in a sago-swamp, and the native is not particular as to its purity. Then, grasping the cord of the strainer and bending down the spring with his left hand, he mixes up the mass in the trough with his right, and presses a handful against the strainer. The white, starchy liquid flows out into the settling-trough, fresh pith is added and the refuse thrown out from time to time; the starch in the milky fluid of the settling-trough soon settles to the bottom, and the surplus water slowly flows away from the spout at the end; here it is often caught in a second settling-trough at a little lower level, so as to recover more of the starch. As soon as the bed of starch—like thick plaster of Paris—nearly fills up the trough, it is scooped out in masses with the hands, rolled on the left fore-arm



WASHING THE PITH.

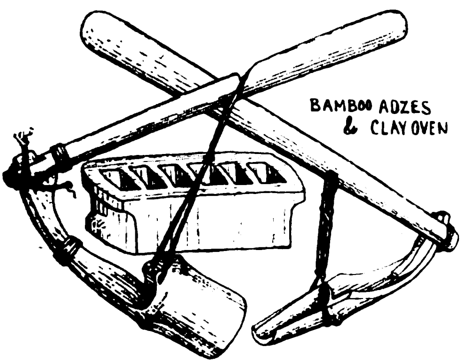
strainer-trough at one end of the main or settling-trough, and the overflow spout at the other. The strainer-trough is supported by stakes at a convenient height to work at; the small end is blocked with a piece of leaf-sheath, and a strainer is fixed at the large end. This strainer is made of segments of the reticulated fibre swathing the bases of the leaf-sheaths of the coco-nut (something like very coarse cloth or sieve-net), neatly sewn together with twine made from thin strips of sago-leaf; the edge of the strainer is turned up or flanged and sewn to the interior of the trough, just inside the large end. The upper end of the strainer is attached to a piece of leaf-cord, and kept stretched by means of a couple of springs made of bamboo or split leaf-stem. A small piece of leaf-sheath is usually placed beneath the strainer-trough to serve as a spout to the settling-trough. The whole apparatus is called the *gutti* or *gouti*, pronounced *gooty* by the natives.

The *gutti* being erected, the operator dumps a into rough sausages, and dropped into sago-leaf jars, in which a little pith refuse has been placed; a little more refuse is plastered on the top, and more leaves are then sewn on and bound over the whole package with rings of leaf-strip. The remainder of the tree is then attacked and converted into sago; the reason why the whole tree is not split at once being that if the pith is exposed too long to the weather, it soon deteriorates—besides, the Malay likes to do things leisurely.

The ground, or rather morass, in which the sago-makers work, is chiefly composed of refuse pith, which smells pestilently as it becomes sour. In this half-liquid, yellowish refuse, and the black sludge of the forest, the natives trudge about, knee-deep in mire, and of course bare-legged, often badly wounded in the feet with the great spines of the leaf-sheaths, which are scattered all around. The swamp in the neighbourhood of the sago-makers is generally thick with palms overgrown with huge creepers; dark and gloomy, except

where the felling of a palm or two lets in the fierce sun, when the native works under shelter of a palm-frond supported on stakes. The atmosphere is hot and steamy, and most days there are heavy showers, whilst the mosquitoes are very troublesome, as the writer found when making these sketches; and they seemed to annoy the natives equally.

The whole apparatus of the sago-makers is wonderfully rude, and yet remarkably effective. There is nothing used in its construction but what grows at hand in the forest. The conical water bucket is made of a piece of leaf-sheath of the sago-palm softened by soaking in water, and sewn together with split rattan. The baskets for pith and jars for finished sago are made of young sago-leaves sewn together with little strips of the leaf-ribs and hooped with the same useful fibre. The adze with which the pith is scooped out of the trunk is of bamboo, strengthened with rattan bindings, and cut squarely across so that the cutting edge is blunt, not V shaped; it therefore keeps its edge longer than a steel tool would, besides rendering



Sago-makers' Tools.

the pith in just the proper condition for extracting the starch. In other parts of Ceram, stone adzes with wooden hafts are in use to-day as they were when Wallace wrote on sago-making in his "Malay Archipelago."

Once built, the *gutti* lasts a long time, and it is very common to see the various stakes and poles used in the rude structure sending forth vigorous shoots and leaves.

The prepared sago is usually baked into small cakes about four by three inches and an inch thick, in a little clay oven with about half-a-dozen slits; the powdered sago is dried and deodorised in the sun for a day or two, then sieved, and again spread out to dry. The powder is then filled into the slits of the oven, which has been previously heated almost to a dull red, face down over a wood fire. The upper side is then covered with plantain leaves, and in a few minutes the cakes are ready. They cost a cent each (about a farthing) in the Malay markets, and keep indefinitely, and are therefore much used on the Malay praus for their long sea voyages. J. C. K.

THE MAIZE PLANT.

Professor F. L. Stewart, of Murrysville, Pa., has been for many years studying the possibilities of the maize plant. Ten years ago it was demonstrated that, with suitable treatment, the plant takes equal rank with the sugar cane and the beet as a sugar producer. Professor Stewart's theory was that, as the maize plant belongs to the same botanical family as the sugar cane, and contains a fair amount of sucrose in its normal condition, it might be cultivated so as to increase its sucrose content up to the point where it would become profitable to work. He discovered, in the course of his experiments, that if the ears were removed at a certain period before the plant would normally cease growing, the period of growth would be increased by from four to six weeks, and during that time the anatomical structure became radically changed. The plant increased in size and weight; the saccharine content increased to more than double its normal amount, with a purity far above that of the natural juice, while the fibre or bagasse furnished material for paper-making of a very high grade. Experiments conducted in some twenty different States during the last few years have confirmed the results obtained at Murrysville.

In a recently-issued statement Professor Stewart estimates the products of maize treated according to his process as follows:—

A ton (2,000 lbs.) of corn cane produced under the Stewart patents, contains an average of 570 lbs. perfectly dry solid matter, and of this, 270 lbs. are in solution in the juice. Of this dissolved matter an average of 240 lbs. per ton is sucrose, 20 lbs. uncrystallisable sugar, and 10 lbs. organic matter not sugar. The average yield of dry crystallised sugar is—

First sugar 96° centrifugal . . .	160 lbs.
Second sugar 89° centrifugal . . .	30 lbs.
Total . .	190 lbs.

About six gallons of molasses, containing about 70 lbs. of uncrystallisable sugar, remain as a by-product which is converted into ethyl spirits producing 5·18 gallons of 95 per cent. alcohol.

A ton of trimmed stalks produces also, when milled and dried, about 300 lbs. of air-dry fibre, which gives about 200 lbs. of dry bleached paper pulp. The average weight of the leaves per acre is approximately one ton, and contains about 300 lbs. of air-dry fibre, or 200 lbs. of finished paper pulp.

In one ton of green ear and husk product there is about 580 lbs. of dry substance, of which 420 lbs. is fermentable matter, 85 lbs. of dry pulp and about 30 lbs. of corn gluten. The fermentable matter will yield half its weight (210 lbs.) for 31·1 gallons of 95 per cent. alcohol. In that portion of the corn belt where a suitable climate and soil can be secured, an average of twenty-five tons, gross weight, of several varieties of corn can ordinarily be grown per acre. Of this fifteen tons are stalks and ten tons green ears and husks.

To summarise, the yield of all products is as follows:—

SUGAR.

First sugar 96°—	
160 lbs. × 15 tons per acre . . =	2,400 lbs.
Second sugar 89°—	
30 lbs. × 15 tons per acre . . =	450 lbs.
Total . .	2,850 lbs.

ALCOHOL.

From ear and husk, fermentable matter—	
210 lbs., or 31·1 galls., 95 per cent. alcohol × 10 tons per acre. . =	311 galls.
From molasses produced from one ton of corn cane—	
35 lbs., or 5·18 galls., of 95 per cent. alcohol × 15 tons per acre. . =	77 galls.
Total . .	388 galls.

PAPER PULP.

Stalk and leaf product—	
213⅓ lbs. per ton × 15 tons per acre . . . . =	3,200 lbs.
Ear and husk pulp, 85 lbs. × 10 tons per acre . . . . . =	850 lbs.
Total . .	4,050 lbs.

The large amount and value of the by-products, the low cost of producing the corn crop, and the extent of territory adapted to its cultivation, all point to the conclusion that the United States can secure from this source all the sugar and paper pulp needed for domestic consumption.

During the past season demonstration tests have been conducted on the Hungarian State Experimental Station, in the extreme north of the country, and the results were so satisfactory that the Chief Chemist of the Agricultural Department is to deliver a special lecture on the new treatment at Buda-Pesth. Even better results may, of course, be expected further south, and in tropical and subtropical countries generally.

PREVENTION OF FLOODS IN THE LAKE OF LUGANO.

An important scheme for regulating the discharge of the flood waters of the Lake of Lugano will shortly be carried out, under the auspices of the Italian and Swiss Governments, who have agreed to defray the cost of the undertaking.

Considerable damage is frequently done by floods to the low-lying lands on the shores of the lake, while serious inconvenience is also caused to the traffic at these times by the roads being in places under water, and communication between the various towns and villages interrupted.

Even the St. Gothard Railway in places is at times under water. This line crosses the lake between Melide and Bissone, on a stone viaduct about half a mile in length. In floods the headway of the arches is so reduced as to stop navigation. With a flood level of two metres (six feet six inches) above the zero on the gauge, even the quays at Lugano are under water, whilst access to the various steamboat-piers is impracticable.

The Lake of Lugano, which has an area of about twenty square miles, is situated partly in Swiss and partly in Italian territory, at a level of 250 feet above the Lago Maggiore, into which it discharges near Luino by means of the River Tresa, at a distance of about eight miles from Ponte Tresa, situated near the western arm of the first-mentioned lake.

The maximum discharge from the lake during the flood of 1896 (the highest recorded) was 600 cubic metres (132,071 gallons) per second, and the minimum falls sometimes as low as four cubic metres (880 gallons) per second.

The level of the highest flood was two metres eighty centimetres above zero on the gauge, whilst the lowest level reached during droughts has been fifteen centimetres below zero, showing a range of three metres five centimetres (ten feet) between flood and drought levels.

In order to remedy this state of things, and to utilise the volume of water for motive power, it is proposed to build a weir at Ponte Tresa, provided with the necessary sluices for controlling the flow of water into the River Tresa, the channel of which will be widened and rectified.

By means of this weir the surface of the lake will be maintained between the levels of ten centimetres and one metre eighty centimetres above zero, allowing thus a range of one metre seventy centimetres (five feet eight inches) for storage purposes, whilst the maximum high-water level will be kept one metre below the highest flood level that has ever been reached.

The regulation of the floods in the Lago Maggiore and Lake of Como is also contemplated by the Italian Government at some future date.

HOME INDUSTRIES.

Anthrax Sterilization.—For many years the terrible scourge of anthrax has levied toll of human and animal life, and until recently it was believed to be an incurable disease. Now, however, it seems permissible to hope that human beings may, to a certain extent, be saved even when in the actual grip of the malady. It is claimed that by the Symons-Jones anthrax sterilization method the anthrax-infected materials imported into this country may be disinfected without impairing their usefulness for the various manufacturing processes which they subsequently undergo. The difficulty in solving the problem of anthrax sterilization has rested hitherto in discovering a method of sterilizing the anthrax spore when embedded in a gelatinous, albuminous, or other colloid body, without injury to the material or fabric to be disinfected. The materials which act as carriers of anthrax are: hides and skins (especially when dry), wool, horse-hair, mohair, rags, etc. Any process which sterilizes

hides and skins will naturally be applicable to their products, so that the adoption of a satisfactory method for the former may be assumed to solve the difficulties in the latter and all other similar cases. But the method must not interfere with any subsequent operation through which the disinfected material has to pass. The usual place of secretion of anthrax spores is on the surface of and immediate inside of a colloidal albuminous mass, such as a blood clot, and the outer "skin" of the spore consists of similar albuminoid matter. The difficulty up to the present has been to obtain a disinfecting solution which would penetrate firstly the dried blood clot, and secondly the hard "skin" (cell wall) of the spore. The treatment with acid solution provides a way out of this difficulty, for it causes the clot and the spore to swell, absorb water, and become very soft and tender. The acid itself has a deleterious effect on the spores, but sterilization by it alone is not sufficient. The process provides for this by treating swollen and tender material with a very dilute solution of a most powerful bactericide.

Railway Accidents.—Recent railway accidents have deepened the impression that the railway companies have been over-slow in adopting up-to-date means of control. In many signal-boxes the instruments which control the trains are said to have been in use a good many years, and to have been put in when railways were very different from what they are to-day. It cannot be well that the lives of passengers should be in the hands of one man who, however competent he may be, is not immune from human failings, when there are means by which he can be automatically protected from the possibility of error. A correspondent recalls that in America, in Australia, and on the London Underground, the signalman in some cases does not see the trains during the time he is on duty; yet not only are they safe, the signalman is absolutely prevented from making a mistake, for the train controls the man, and not the man the train, as far as the possibility of a wrong movement is concerned, by means of what is known as the track circuit. Had this system been in operation in the Willesden case, and the signalling instruments under track circuit control, and coil locks on the signal levers, controlled through the same track, it would have been impossible for the signalman to have admitted the other train, or have moved the wrong signal lever. In the Hawes Junction case, had the instruments been under the same control, and the signals put to danger by the engines by means of a mechanical contrivance, not only would the signal have been at danger for the express, but the fact of the engines being on the line would have prevented the signalman from accepting the express, or with a coil lock track controlled he would have been unable to pull the lever off again till the engines were clear of the section. There is one way to prevent these accidents, that is to have power-worked signals at all junctions, track circuit controlled throughout and where signals are mechanically operated, track circuit control of the instruments, and coil locks which should be fixed on all signal levers, with mechanical replacer on all main line signals.

Raw Cotton.—The expectation that the present high price of cotton will lead to a great extension of the cotton acreage in the southern states of America does not seem to rest on any solid foundation. In fact, the production of cotton there is not keeping pace with the increased demand for cotton goods. On the contrary, the growth of maize is rather encroaching on the growth of cotton in America. At current prices it pays the farmer in the southern States better to grow maize than to grow cotton. It becomes, therefore, increasingly important to encourage the cultivation of cotton elsewhere. Last week Sir Percy Girouard, the Governor of the British East Africa Protectorate, addressed a special meeting of the Council of the British Cotton-Growing Association at Manchester on the subject of cotton-growing in East Africa and Uganda, but more especially in the Protectorate. We are promised from Uganda in a short number of years something like 15,000 bales of upland American variety, whilst in the Protectorate there are large areas of land apparently eminently suitable for cotton-growing, but there are practically no natives on the land. Sir Percy Girouard says that the valleys of the Juba and Tana rivers are specially suitable for cotton-growing, and that on the British side of the Juba, which is the frontier line between British and Italian territory, there are about half a million acres suitable for irrigation. The Governor does not think that the labour question will be a very difficult one. At present the plantations on the coast have no difficulty in obtaining labour at very reasonable rates from the highlands of East Africa, where there are several million natives. But cotton-growing in the Protectorate cannot be developed properly by small men, and the Governor suggests that it should be made the subject of a scheme by means of irrigation on a large scale, such as has been suggested for the Sudan. The British Cotton-Growing Association is ready to render all possible assistance, and they have promised to join in experimental work. Assuming such work supports the conclusion that cotton-growing in the Protectorate can be made commercially successful, it will be for the general investor to find the large capital that will be required to utilize the whole of the cotton area. Obviously it would be unreasonable to expect Lancashire, with her immense and expanding industries, to finance, unaided, great schemes of cotton development in distant dependencies.

Iron-Ore Deposits.—It is stated that a strong English company has secured large iron-ore deposits in Brazil with the object of mining and shipping them to this country on a big scale. The

property so secured is at Itabiro do Matto Dentro, in the State of Minas Geraes, and it is said to contain some 60 to 70 million tons of ore, and will, in the opinion of experts, be found eventually to contain anything from 500 million to 1,000 million tons of ore. As to the quality of ore, it is said that "many millions of tons run from 69·3 to 69·8 per cent. of iron, 0·10 per cent. of silica, 0·004 to 0·01 per cent. of phosphorus, and 0·016 per cent. of sulphur, with almost no moisture. This is practically pure iron oxide." The extension of the railway to the mines, a distance of about thirty miles, has already been arranged, and the contract for the electrification and the equipment of the line, to carry a minimum of two million tons a year to the coast, has been given to a British firm. Estimates of the cost of landing the ore here are much lower than present quotations for ordinary 50 per cent. Spanish rubio. It is said that the quarrying of the ore, anyway for some time to come, will be a very simple work, and the estimated cost of putting it on waggons is between 1*s.* and 1*s.* 9*d.* per ton.

The Year's Trade.—The figures of our foreign trade in 1910 are a very agreeable study. Although the internal trade of the country is of much greater value and magnitude than the foreign trade, without the foreign trade the internal trade would not be large, for the expansion of the internal trade of the country is largely governed by the volume of our foreign trade. Expansion of our foreign trade means that the people are better able to obtain from abroad the food and raw materials required for their maintenance and prosperity. In 1910, the value of the net imports reached £574,664,000, or nearly £13 per head of the population. In an interesting article on our foreign commerce, the *Statist* points out how greatly the improvement that has come over the country is due to the renewed enterprise of our investors in using their capital for increasing the world's supplies of food and raw materials. In 1900, the value of the exports of British goods was £291,000,000; in 1910, it reached £430,000,000, an expansion in a single decade of £139,000,000, or 47 per cent. And this increase in value is not due to a rise in the price of our products, for prices in 1910 were slightly lower than prices in 1900. The increase in the quantity of British goods exported in 1910 in comparison with 1900 was 48 per cent. This great increase in the export trade of the country would have been impossible had not a great deal of capital been invested in British industries as well as an unprecedented investment of British capital in other countries for increasing the world's supplies of food and raw materials. "It cannot," says the *Statist*, "be too clearly understood that when we do not invest abroad we not only make no provision for our future supplies of food and raw materials, but we also make relatively little provision for an increased output of manufactured goods in this country, and that we use our new capital for the provision of luxuries which tend to diminish rather than to increase the well-being of the nation."

The Miners' Eight Hours Act.—It is understood that the Home Secretary will receive a deputation, representing the Miners' Federation of Great Britain, for the purpose of discussing the working of the Eight Hours Act. It is complained that in some districts there is a systematic evasion of the Act, and the Home Secretary will be urged to take legal proceedings against the offenders. The Welsh miners will urge upon Mr. Churchill the necessity for an amendment of the Act in directions where it has been found to cause dissatisfaction amongst the men employed on "shifts." It is perhaps too soon to speak with confidence upon the working of the Act, but, whether right or wrong, in the opinion of many well competent and placed to express an opinion, it is doing more harm than good.

GENERAL NOTES.

INTERNATIONAL HYGIENE EXHIBITION, DRESDEN, 1911.—Probably in no direction have greater strides been made than in the science of hygiene in the time which has elapsed since the "Exposition Internationale d'Hygiène et de Sauvetage" was held at Brussels in 1876; and it is expected that the Exhibition, to be opened in Dresden in May next, will present a complete record of the achievement of hygiene up to the present day. In view of the importance of the occasion —arrangements having already been made for over two hundred conferences and congresses in which all the great sanitary experts of the world will take part—a special interest attaches to the appeal, signed by Sir Thomas Barlow, President of the Royal College of Physicians, and Lord Ilkeston, on behalf of the British Executive Committee of the Exhibition, in which the sum of £10,000 is asked for, in order to secure the proper representation of this country at Dresden. In the spring of 1910 the German Government issued an invitation to the Governments of all the chief States of the world to take part in the Exhibition, and Great Britain is the only important Power by whom the invitation was not officially accepted. There is, therefore, a grave danger that this country, the admitted leader in hygienic science, may be the only nation of importance which is not represented. The Governments of France and Russia have each voted £20,000, while the Japanese Government has allocated £35,000 for the purpose; and it is earnestly to be hoped that the British Executive Committee will receive the sum for which they ask at the earliest possible date. Subscriptions should be sent to the Secretary of the Committee, 47, Victoria-street, S.W.

UNIVERSAL RACES CONGRESS.—The first Universal Races Congress will be held in the central building of the University of London, South Kensington, from July 26th–29th, 1911. The object of the Congress will be to discuss "the general relations subsisting between the peoples of the

East and those of the West, between so-called white and so-called coloured peoples, with a view to encouraging between them a fuller understanding, the most friendly feelings, and a heartier co-operation." Papers will be read and discussions held on the following subjects:—1. Fundamental Considerations — Meaning of Race and Nation. 2. General Conditions of Progress. 3. Peaceful Contact between Civilisations. 4. Special Problems in Inter-Racial Economics. 5. The Modern Conscience in Relation to Racial Questions. 6. Positive Suggestions for Promoting Inter-Racial Friendliness. The Congress has already aroused widespread interest. Among its supporters, who represent some fifty countries, are twenty-five Presidents of Parliaments, the majority of the Members of the Permanent Court of Arbitration and of the Delegates to the Second Hague Conference, twelve British Governors, and eight British Premiers, some hundred and thirty Professors of International Law, and the leading Anthropologists and Sociologists. The Council of the Royal Society of Arts have also intimated their willingness to promote in any way in their power the objects of the Congress. Further particulars may be obtained of Mr. G. Spiller, Hon. General Secretary, 63, South Hill Park, London, N.W.

PROCEEDINGS OF THE PHYSICAL SOCIETY.—In order to secure the more prompt publication of papers read before the Physical Society of London, the Council have decided henceforth to issue the "Proceedings" in five parts, at two-monthly intervals, during each session, and they hope it may be possible later on to issue ten parts at monthly intervals. The publications will be on sale at the Publishers to the Society, *The Electrician* Printing and Publishing Co., Ltd., 1, 2, 3, Salisbury-court, Fleet-street, London, E.C.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

JANUARY 25.—HORACE M. WYATT, "Motor Transport in Great Britain and the Colonies." The Hon. RICHARD CLERE PARSONS, M.A., Vice-President of the Society, will preside.

FEBRUARY 1.—PHILIP JOSEPH HARTOG, M.A., B.Sc., "Examinations and their bearing on National Efficiency." The EARL OF CROMER, G.C.B., O.M., G.C.M.G., K.C.S.I., C.I.E., Vice-President of the Society, will preside.

FEBRUARY 8.—Captain A. J. N. TREMEARNE, B.A., D.Anth., "Some Nigerian Head-Hunters."

FEBRUARY 15.—GEORGE A. STEPHEN, "Modern Machine Book-binding." JOHN MURRAY, J.P., D.L., F.S.A., will preside.

FEBRUARY 22.—Professor J. WERTHEIMER, B.Sc., B.A., "Water-Finders."

MARCH 1.—Dr. LEONARD HILL, F.R.S., "Caisson Sickness and Compressed Air."

MARCH 8.—JAMES CANTLIE, M.A., M.B., C.M., D.P.H., "Plague and its Dissemination." Sir SHIRLEY FORSTER MURPHY, M.R.C.S., will preside.

Wednesday afternoon, at 4.30 o'clock:—

MARCH 15.—Colonel CHARLES EDWARD CASSAL, V.D., F.I.C., "The Adulteration of Food." The Right Hon. the Lord Mayor of London will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

FEBRUARY 9.—R. A. LESLIE MOORE, I.C.S. (retd.), "Indian Superstitions." Lord LAMINGTON, G.C.M.G., G.C.I.E., will preside.

MARCH 16.—CLAUDE HAMILTON ARCHER HILL, I.C.S., C.S.I., C.I.E., "Education in India."

APRIL 27.—Sir THOMAS HENRY HOLLAND, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India." Lord AVEBURY, D.C.L., LL.D., F.R.S., will preside.

MAY 25.—W. R. H. MERK, I.C.S., C.S.I., LL.D., "The N.W.F. Province of India."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

JANUARY 31.—F. DOUGLAS OSBORNE, M.Inst.M.M., "The Tin Resources of the Empire." Sir WILLIAM HOOD TREACHER, K.C.M.G., will preside.

FEBRUARY 28.—The HON. SIR RICHARD SOLOMON, K.C.B., K.C.M.G., K.C.V.O., K.C., M.A., High Commissioner for the Union of South Africa, "The Resources and Problems of the Union of South Africa."

APRIL 4.—Captain R. MUIRHEAD COLLINS, C.M.G., "Australia and her Resources."

MAY 9.—F. WILLIAMS TAYLOR, "Canadian Banking."

CANTOR LECTURES.

Monday Evenings, at 8 o'clock:—

FREDERICK WEDMORE, "Etching." Two Lectures.

Syllabus.

LECTURE I.—JANUARY 23.—"The Old Masters." The Cradle of great Etching—Rembrandt's place—Ostade and Bega—Vandyke—Landscape and Animal Subjects in the Low Countries—The Classic Landscape — Claude — Links with the Moderns—Etching no "Minor Art."

LECTURE II.—JANUARY 30.—"Modern Etching." Goya—Wilkie and Geddes—The Silence before the Revival—The great French Outburst—Méryon, Bracquemond and Jacquemart — Haden and Whistler—Themes mainly Landscape, Portraiture, Architecture—The Etching of To-day.

Professor ADRIAN J. BROWN, M.Sc., "Brewing and Modern Science." Four Lectures.

Syllabus.

LECTURE I. — FEBRUARY 6. — Introduction. Dr. Graham's Lectures Thirty-seven Years Ago—The Brewing Process a succession of Complex Bio-chemical Changes—Barley: Classification of types used by the Maltster—Barley from the Agriculturist's and Brewer's Points of View—Present Position of Knowledge regarding Characteristics of Malting Barley—Results of recent Experiments on Barley Cultivation in Ireland, etc.

LECTURE II.—FEBRUARY 13.—"Malting." Constitution of the Barleycorn — Character of Changes during Germination—Investigations of the Biochemistry of Germination—The Barleycorn a highly-specialised seed, etc.

LECTURE III.—FEBRUARY 20.—"The Mashing Process." The Chemistry of Starch and its Transformation Products—Protein Changes during the Mashing Process.

LECTURE IV.—FEBRUARY 27.—"The Fermentation Process." Previous Treatment of the subject by Dr. G. Salamon in 1888—The Pure Yeast Question in Brewing—Zymase and Modern Views of Alcoholic Fermentation—Nitrogen Assimilation—The so-called "secondary" products of Fermentation, etc.—Conclusion.

Professor J. A. FLEMING, M.A., D.Sc., F.R.S., "Applications of Electric Heating." Four Lectures.

March 6, 13, 20, 27.

ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

May 1, 8, 15, 22.

Dates to be hereafter announced:—

FRANK M. ANDREWS, "Architecture in America."

ARTHUR CHARLES DAVIS, F.C.S., Assoc.Inst.C.E., "The Manufacture and Testing of Portland Cement."

GEORGE B. HEMING, "Art Education in Jewellery and Goldsmithing."

Professor RAOUL PICTET, "Les Basses Températures."

Sir WILLIAM ABNEY, K.C.B., D.C.L., D.Sc., F.R.S., "The Quantitative Measurement of Colour-Blindness."

HAL WILLIAMS, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

NOEL HEATON, B.Sc., F.C.S., "The Production and Identification of Artificial Gems."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 23...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. F. Wedmore, "Etching." Lecture I.—"The Old Masters."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. W. R. Baldwin-Wiseman, "The Conservation of our National Water Resources."

Victoria Institute, 1, Adelphi-terrace, W.C., 4.30 p.m. Rev. A. R. Whately, "The Demand for a Christian Philosophy."

London Institution, Finsbury-circus, E.C., 5 p.m. Professor Walter Raleigh, "Hazlitt."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. T. Fyfe, "Germany and the Germans."

British Decorators, Painters' Hall, Little Trinity-lane, E.C., 8 p.m. Mr. J. Sibthorpe, "Our Visit to the Rhineland."

TUESDAY, JANUARY 24...Sociological, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor F. W. Mott, "Heredity." (Lecture II.)

Brewing, Institute of (Scottish Section), Caledonian Station Hotel, Edinburgh, 7.45 p.m. Mr. H. W. Harman, "Practical Notes upon (1) Influence of Air upon Malting and Brewing, and (2) Brewing Value of Hops."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. C. W. King, "Sand-Movements at Newcastle Entrance, N.S.W." 2. Mr. C. S. R. Palmer, "Fremantle Harbour-Works, Western Australia." 3. Mr. G. H. Halligan, "The Bar Harbours of New South Wales."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. F. Stanley, "The Photography of Spectra, with Notes on the New Féry Spectrograph."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. The Hon. J. G. Jenkins, "Papua and the Papuans."

WEDNESDAY, JANUARY 25...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. H. M. Wyatt, "Motor Transport in Great Britain and the Colonies."

Geological, Burlington House, W., 8 p.m.

United Service Institution, Whitehall, S.W., 3 p.m. Mr. W. Cobb, "The Nelson Touch."

Royal Society of Literature, 20, Hanover-square, W., 5 p.m. Professor M. A. Gerothwohl, "The Englishman in the Eighteenth Century French Drama."

Mining and Metallurgy, at the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. 1. Discussion on Mr. H. C. Bayldon's paper, "Notes on Chilian Mills in Russia." 2. Mr. N. A. Loggin, "Notes on Placer Mining, with Special Reference to Hydraulic Sluicing."

THURSDAY, JANUARY 26...Electrical Engineers, Victoria Embankment, W.C., 8 p.m. 1. Mr. W. T. Taylor, "Long Distance Transmission of Electrical Energy." 2. Messrs. R. Borlase Matthews and C. T. Wilkinson, "Extra High Pressure Transmission Lines."

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Child Study, 90, Buckingham Palace-road, S.W., 7.30 p.m. Mrs. M. Scharlieb, "Recreational Activities of Girls during Adolescence."

London Chamber of Commerce, Skinners' Hall, Dowgate-hill, E.C., 2.30 p.m. Address by Sir George H. Reid, "Australia—the 123rd Birthday of the Empire's only Continent."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. O. Bradley, "Mignon's Song."

Royal Institution, Albemarle-street, W., 3 p.m. The Astronomer-Royal, "Recent Progress in Astronomy." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. A. H. Blake, "History in Caricature and Satire."

Brewing, Institute of (Midland Counties Section), White Horse Hotel, Congreve-street, Birmingham, 7 p.m. Dr. A. Slator, "The Rate of Alcoholic Fermentation."

FRIDAY, JANUARY 27...Royal Institution, Albemarle-street, W., 9 p.m. Professor W. H. Bragg, "Radioactivity as a Kinetic Theory of a Fourth State of Matter."

North-East Coast Institution of Engineers and Shipbuilders, Newcastle-on-Tyne, 7.30 p.m.

Physical, University College, Gower-st., W.C. (Physics Lecture Theatre), 5 p.m. 1. Professor F. T. Trouton, "A Demonstration of Phase Difference between the Primary and Secondary Currents of a Transformer by means of a Simple Apparatus." 2. Professor J. A. Fleming, "A Note on the Experimental Measurement of the High Frequency Resistance of Wires." 3. Professor J. A. Fleming and Mr. G. B. Dyke, (a) "The Measurement of Energy Losses in Condensers traversed by High Frequency Oscillations." (b) "Some Resonance Curves taken with Impact and Spark Discharges."

SATURDAY, JANUARY 28...Royal Institution, Albemarle-street, W., 3 p.m. Mr. Arthur Hassall, "Problems in the Career of the Great Napoleon." (Lecture II.)

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FRIDAY, JANUARY 27, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, JANUARY 30th, 8 p.m. (Cantor Lecture.) FREDERICK WEDMORE, "Etching." (Lecture II.—"Modern Etching.")

TUESDAY, JANUARY 31st, 4.30 p.m. (Colonial Section.) F. DOUGLAS OSBORNE, M.Inst.M.M., "The Tin Resources of the Empire." Sir WILLIAM HOOD TREACHER, K.C.M.G., will preside.

WEDNESDAY, FEBRUARY 1st, 8 p.m. (Ordinary Meeting.) PHILIP JOSEPH HARTOG, M.A., B.Sc., "Examinations and their bearing on National Efficiency." The EARL OF CROMER, G.C.B., O.M., G.C.M.G., K.C.S.I., C.I.E., Vice-President of the Society, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday Evening, the 23rd inst., Mr. FREDERICK WEDMORE delivered the first lecture of his course on "Etching."

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday afternoon, January 19th; Sir FELIX SCHUSTER, Bart., in the chair. A paper on "Banking in India" was read by Mr. REGINALD MURRAY, formerly Manager of the Chartered Mercantile Bank of India, London and China, in the Straits Settlements and India.

The paper and discussion will be published in a subsequent number of the *Journal*.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

SEVENTH ORDINARY MEETING.

Wednesday, January 25th, 1911; The Hon. RICHARD CLERE PARSONS, M.A., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Daneff, St., LL.D., Sofia, Bulgaria.

Forman, Robert Brodie, High Pastures, Elmswood-road, Aigburth, Liverpool.

Gunn, Donald, Hogtrow, Hook Heath, Woking.

Hudson, Philip Reginald, A.R.S.M., 807, Majestic-building, Denver, Colorado, U.S.A.

Lal, Pyarai, Zamindar of Burotha, Aligarh, India.

Schoenfeld, L. S., 807, Majestic-building, Denver, Colorado, U.S.A.

Shamasastry, R., B.A., Government Oriental Library, Mysore, India.

Simkins, Arthur C., M.E., 807, Majestic-building, Denver, Colorado, U.S.A.

Tattersall, Alfred Rishworth, 75, Mark-lane, E.C.

Vernon, Arthur Longley, 10, Abbey-road, St. John's Wood, N.W.

Whiteley, Richard H., National State Bank Block, Boulder, Colorado, U.S.A.

Worsham, Ernest Lee, State Board of Entomology, Atlanta, Georgia, U.S.A.

The following candidates were balloted for and duly elected members of the Society:—

Borthwick, Miss Jessica, 33, Rue du Jardin, Ostend, Belgium.

Eastburn, Mrs. Adelaide, 14, Ravenscourt-mansions, Hamlet-gardens, Ravenscourt-park, W.

Haslehust, Ernest W., 72, Burnt Ash-hill, Lee, S.E.

King, Alexander Freeman, C.B., 44, Foxgrove-road, Beckenham.

Miles, George W., 29, Central-street, Boston, Massachusetts, U.S.A.

Mylcrist, Captain Stanley, 560, Sunder-road, Karachi, India.

Wigram, Reginald, J.P., M.Inst.C.E., Chapel Allerton, Leeds.

The paper read was—

MOTOR TRANSPORT AT HOME AND IN THE COLONIES.

By Horace M. Wyatt,
Editor of "Motor Traction."

In the course of this paper the author will attempt to indicate more particularly the enormous field which exists in Greater Britain for the mechanically-propelled road vehicle, and the influences which have operated, and will operate, for or against the more extensive use of motor traction, not only in this country, but throughout the Empire. In order to deal with this complex subject without unnecessary confusion, the paper is divided into sections treating of different phases of development and prospects.

In the first place, it is abundantly necessary to explain, more especially for the benefit of those resident in distant countries, how outside causes, not intimately connected with the design of the vehicles themselves, contributed towards those early failures which were undoubtedly very numerous. We, who are on the spot, are in a position to realise quickly enough when failure has turned to success, but such realisation comes but slowly to those who have to depend largely for their information on visitors from this country, and on rumour which percolates to them through sources not invariably reliable. In tracing the progress that has been made and the causes which have assisted in overcoming prejudices against motor vehicles for business purposes, and in establishing them as an essential of the traffic of the future, it may be advisable to treat of certain specific instances of a typical nature.

After having shown how satisfactory is the position which the industrial motor vehicle is now steadily attaining in this country, the next step is to consider what modifications in design are usually needed to fit the products for the markets of Greater Britain. In this section it is necessary to touch on the relations between the British manufacturer and the colonial buyer. These relations, unfortunately, do not always show as much mutual respect and good feeling as might be wished. That faults exist must be admitted, but I shall hope to show that such faults are not all on one side, and that much of the attitude of the British manufacturer, which is often made to appear as unduly conservative and unprogressive, will, in fact, be seen, if given broad consideration, to be of real benefit to progress.

It is, of course, useless to consider the production of vehicles specially suited for use in the colonies unless there is a likelihood of a real demand sufficient to justify the standardisation of types. The question of local demand throughout the Empire is therefore dealt with in an appendix, for the contents of which the author is almost wholly dependent on information received from a very large number of correspondents resident in Greater Britain.

Lastly, it seems advisable to consider not only how the trade between the Mother Country and the colonies may be allowed to grow, but how that growth might be accelerated in a legitimate and useful manner, and under this heading a few suggestions are put forward, which, it is hoped, will at least be thought worthy of consideration, and possibly of discussion.

With these prefatory remarks, I will now turn to the first section of my paper, and attempt to deal as completely as possible in the limited time at my disposal with the matters outlined above.

Section I.—Early Failures and Recent Successes.

Those who trifle with the laws of Nature always find sooner or later that they must pay the penalty. One of these laws is that growth and progress shall be gradual, and that, though they may be accelerated by artificial means, any such acceleration leads to weakness or early decay. A good example of this is afforded by the produce of the land. Admittedly, earlier fruits can be obtained by means of hot-houses or intensive culture, but plants which have been so treated will undoubtedly suffer in hardiness and in their capacity to stand the normal climatic conditions of the country. The law holds good equally in the case of a new industry, and in almost every phase of progress those who have pushed ahead too fast have found this out to their cost.

The fact that the motor vehicle might be made into a really practical implement for more heavy work than mere touring and enjoyment was realised so suddenly that it almost amounted to a revolutionary discovery. No sooner had it been shown that mechanical haulage might be employed for omnibuses, for vans, and for lorries, than there was an indiscriminate rush to be amongst the first to reap the benefits, which it was rightly foreseen must sooner or later accrue. As is usual in such a case, the result was that the new implement was put to uses for which it was totally unsuited, and was designed

constructed, or adapted with a haste which prohibited thoroughness.

The Progress of the Public-Service Motor.—To trace the causes of early troubles in the motor traction movement with any fairness, it is essential to separate the various classes of vehicle and to consider them individually. Motor omnibuses afford, perhaps, the most striking example of recovery from early troubles. So soon as it was demonstrated that these machines were economically possible, there was a mad scramble to place them upon the streets before competitors could do likewise. Even then a few, but very few, manufacturers had studied the question sufficiently to produce a sound chassis. These were bought up almost instantaneously, and orders for scores and even hundreds went begging in the open market. The result was inevitable. Manufacturers with insufficient experience saw opportunities for quick sales and substantial profits. Continental firms were very willing to step into the breach left by the rather deliberate but eminently responsible British manufacturer. The streets were flooded with the first thing on which the company promoters could lay their hands. Many of these gentlemen themselves, concerned not at all with the mechanical aspect of the question, and to no great extent with the ultimate welfare of the ordinary shareholders, saw in the motor omnibus simply an opportunity for a "boom," which might well leave promoters the better off, whatever its effect on all others concerned. In many cases the vehicles, unsuitable in themselves and difficult enough to run with any satisfaction, were put into the charge of engineers who did not understand the problem with which they were faced, and who had behind them the doubtful support of directors who could not realise that a mechanical vehicle, like any other machine, requires regular supervision and adequate attention. Garages and repair shops were poorly staffed and insufficiently equipped, and the vehicles were wanted upon the road at every conceivable moment to earn the maximum of money in the minimum of time. For the moment the public rejoiced in the increased speed of the new conveyances, laughed in a good-humoured way at their failings, and bore them no particular ill-will for their defects.

Temporary Unpopularity.—Presently, however, people had time to look at the development of the new traffic more carefully. They realised that if the thing were to exist at all it would sooner or later become universal, and that whatever drawbacks it might bring with it would have to be considered seriously, and not merely as fit subjects for humorous drawings. Public opinion is always inclined towards extremes, and from an enthusiastic welcome it veered round somewhat suddenly, and—influenced perhaps a by few unfortunate accidents—changed from friendliness to disgust. In so doing it was helped by the fact that, by this time, many of the cars had been on the road long enough to become exceedingly noisy, and drivers had grown sufficiently sure of themselves to cultivate a contempt for other forms of traffic and a desire to out-do their competitors in the matter of speed. Thus it came about that, just when operating companies had begun to realise that their work was hardly as simple as they had expected, and that they had to find the solution of many mechanical problems before their vehicles would be perfectly reliable, they were faced with further difficulties imposed through the medium of the licensing authorities. As a result, too, of their excess of zeal, competition became too severe, and fares were cut down to a basis on which it was almost impossible to show a profit. It was at this time that the impression began to get about that the motor omnibus was a failure, and, judging from letters which the writer has received even recently, the idea is still fairly rooted in many parts of the world, more especially in distant countries, to which general impressions, as distinct from mere statements, take some time to spread.

What has gone before applies perhaps more directly to London than to the country generally, but small services in provincial towns often reproduced on a lesser scale the state of affairs briefly outlined above. More especially did the promoters of these local services err owing to the belief that mechanical vehicles might be run without any adequate overhaul or attention. Many of these little concerns, possessing only small financial support, realised too late that a punctual and regular service possessed the elements of success which would not result from a haphazard and variable supply of vehicles, even though they might be more or less available for some sixteen hours of the day.

Not the least among the troubles of those interested in motor omnibuses has been the opposition of tramway interests generally and of municipal authorities in particular. There seems to be no adequate reason why the tram, as opposed to the road vehicle, should be inseparably connected with municipal enterprise. This is, however, very frequently the case, and thus the motor omnibus company found itself obliged to apply for licences to its own

competitors for traffic. With all these influences working together it is not surprising that some operating companies failed entirely, while others struggled for a bare existence instead of showing the substantial profits which had been fondly anticipated.

The Turn of the Tide.—In the last two years, however, matters have improved very materially. Companies, finding it impossible to compete so fiercely with one another, resorted to amalgamation. This not only allowed of some increase in fares, but did away with racing, which was at once a danger to the public and the cause of rapid depreciation of the mechanism of the vehicles. The companies which had not attempted too much and were properly managed and equipped began to show, beyond a doubt, that failure was not caused by the system but by its misapplication. Individuals and small concerns in town and country began to see the possibilities of profit in vehicles of the char-à-banc class, and showed that mechanically-propelled public-service carriages might be profitably worked even singly or in small numbers. The public became more and more converted to the utility of the motor omnibus, and the efforts of the licensing authorities, whilst bearing hardly upon the operating companies for a time, undoubtedly tended towards the production of a more agreeable class of vehicle.

In its annual report, published at the end of the year 1909, the London General Omnibus Co. showed a profit on the lines worked by motor omnibuses and a loss where horses were employed, and announced its intention of doing away definitely with animal traction. That this statement of policy was a genuine one has been shown by the progress which has been made since that time.

Official Confirmation of Progress.—The present state of affairs was well expressed in the report of the London Traffic Branch of the Board of Trade for 1909:—"Worn-out horse omnibuses are not being replaced; further wastage will be made good and additional demands supplied largely by adding to the number of motors. The expense of maintaining and running the latter has been reduced, and they now pay better than the others."

The experience of London has been corroborated by that of Paris. When the concessions possessed by the big operating companies of that city terminated early in 1910 they were renewed only on condition that the whole of the horsed vehicles should be replaced by motors within a limited period.

It is not only when compared with the horse that the motor omnibus is now capable of showing itself a strong claimant for notice. In certain provincial towns, as for example Eastbourne and Folkestone, the local passenger traffic demands are now met entirely, or to a very great extent, by motor vehicles, which are preferred to trams. In the report which is quoted above the following significant sentences appear:—"As rivals to tramways, motor omnibuses are likely to become more formidable than they have been hitherto. As an instrument of locomotion the omnibus is in its infancy, whereas the tramway has come to maturity. Even in the imperfect conditions that have prevailed hitherto, omnibus competition has been so effective that municipal authorities have been induced to appeal to the ratepayers to patronise their own tramways. There is, indeed much in the present aspect of the motor industry that may give pause to the promoters of tramways."

Operating Companies their Own Manufacturers.—Before considering special cases, there is one other point which deserves mention. This is the tendency of some of the large operating concerns to manufacture their own vehicles in their own works. It has certainly been shown that successful results may under certain conditions be obtained in this way, but it is necessary to warn those who may contemplate following the lead of the big companies as to certain dangers which beset their path. In the course of some five or six years' experience with a large fleet of vehicles of various types, it stands to reason that the engineers of a big operating concern gain an enormous amount of useful experience in constructional details which may well fit them to superintend the complete work of design and construction, provided that their shops are adequately equipped for the purpose. It would, however, be suicidal for an operating company without such experience to attempt its own building. For example, if a company were formed to run a large number of omnibuses in a British colony, it would be madness for it to attempt to dispense with the services of the experienced manufacturer. His experience has only been bought at a high price, both in time and money, and however clever the designers and managers of an absolutely new concern may be, the first productions cannot be made to embody all the apparently trifling and sometimes invisible results of the study and experiment of years. Operating companies which were among the pioneers in the motor traction movement had facilities which could hardly be duplicated at

the present moment for studying the strong and weak points of numerous designs, and perforce gained much bitter but valuable experience, which they can now reasonably utilise for their own benefit. New companies, if wisely directed, would not at the present day purchase mixed fleets containing a large variety of types and makes, and consequently their experience would never be so complete as that of the concerns which have gone through the mill during the most discouraging stages of development.

The London General Omnibus Co.—In taking one or two concrete examples of progress, one naturally turns first to the London General Omnibus Co., with its fleet of motor omnibuses running into four figures. In the year ending June, 1908, the separate companies which are now combined together under the title of the London General showed an aggregate loss of something over a quarter of a million, and consequently the report for the ensuing fifteen months, which showed a debit balance of £33,400, could not be held to be altogether unsatisfactory. The chairman of the premier company, when this report was issued, stated clearly that a considerable profit had been shown on the working of the motor omnibuses, and a corresponding loss on the operation of horsed vehicles, and announced that the policy of the company from that time onward would be to replace horses by motors until the whole fleet depended solely on mechanical traction. An unsatisfactory feature of the report was that no allowance had been made for depreciation, the auditors calling attention to this omission. During the last fifteen months or so, the company has continued to make progress in the reduction of the running expenses of its vehicles, and it is satisfactory to be able to record the fact that this economy in maintenance is to a large extent responsible for the satisfactory report for the year ending September, 1910. The improvement shown is certainly remarkable, a deficit of £33,400 being turned into a profit of £61,135. This allowed of the payment of full arrears of dividend on the preference shares, and had it not been for the tax on petrol, which hits the company very hard, some dividend might also have been paid on the ordinary shares. Even as it is, the steady advance which has followed the more extensive use of motor vehicles is a full justification of the motor omnibus in general, and of the policy of the company in particular. The present report is rendered all the more satisfactory by the fact that the auditors have not, as on previous occasions, called attention to any lack of allowance for depreciation or any other regular charges.

Other London Companies.—Smaller companies operating in London, as for example the Great Eastern and the Central Omnibus Companies, have been financial successes from the start, this being partly due, no doubt, to the fact that they exercised great caution during the most trying stage of the industry. The Scottish Motor Traction Co., operating in Edinburgh, has also given satisfactory results, paying a regular and reasonable dividend to its shareholders.

Provincial and Colonial Examples.—As an example of a service in a provincial town one may take the Motor Omnibus Department of the Corporation of Eastbourne. Ever since this concern came under its present management it has shown a profit on each year's working. The last report has shown a balance of some £660 as against £250 in the previous year. The latest result is the best up to date, and this fact is noteworthy, since it (and many others like it) shows that the life of a motor omnibus is longer than was anticipated in many quarters, and that the costs of operation need not go up from year to year. In Eastbourne the services are not run under ideal conditions, since the traffic receipts are very low in the winter months, and the loss then incurred has to be made up before the summer traffic can show a net profit. The winter running is to a great extent responsible for the fact that the total operating costs per mile work out to about 1*s*. 1*d*., whereas in London they can be kept down to something like 9*d*., inclusive of all possible charges.

As a final example, the motor omnibus service of the Federated Malay States Railway may be mentioned. Exclusive of depreciation, the aggregate cost per mile comes out at just over 1*s*., although the fleet is not kept really fully employed. This figure of cost shows a margin of profit of about 2*d*. per mile, of which 1*d*. might reasonably be set aside for depreciation. As a matter of fact, the company has gone to extremes in this respect, and has made a big and abnormal allowance, which gives an unfairly bad impression of the results of the year's work. It is at least interesting to note that the Federated Malay States Railway's fleet numbers almost fifty vehicles, which in itself gives some idea of the possibilities of development of road traction in connection with railways throughout the Empire.

At home many of the largest railways have very substantial fleets of motor vehicles, the

Great Western Railway being the largest users of this class. At first almost all the vehicles owned by railways were of the char-à-banc or omnibus type, but recently there has been a satisfactory tendency towards the purchase of goods vehicles, while internal-combustion rail motors are used on light railways and in districts where traffic is not fully developed or comparatively small conveyances are required. These will doubtless soon be employed, especially on colonial railways, far more extensively than they are at present.

The Char-à-banc and Waggonette.—In dealing at some length with motor omnibuses it must be pointed out that the statements made are not only applicable to the double-deck motor omnibus of the ordinary type, but, generally speaking, to all motor conveyances designed for the carriage of passengers in considerable numbers. The services of the Federated Malay States Railway, and many of those of the home railways, are worked with single-deck vehicles, as are also numerous other services, such as those in the neighbourhood of Folkestone; and, generally speaking, the demand for public-service vehicles in the colonies will be in the direction of the char-à-banc, waggonette, or single-deck omnibus, rather than the double-deck type, which is suited especially for town work. In Great Britain itself there are an enormous number of motor chars-à-bancs owned singly or in twos and threes by jobmasters, hotel proprietors, and others, and working for the most part very regularly, and with considerable profit to their owners.

The Motor Cab.—I have devoted some little time to the motor omnibus, as this class of vehicle is called upon to perform work of unexampled severity, and I think it is a foregone conclusion that if, as is actually the case, the motor omnibus is a proved success, other vehicles, such as motor cabs, vans, lorries, and all classes of trade vehicles, may be to some extent taken for granted. Before leaving the public-service vehicle altogether a few moments may, however, be given to the motor cab. The growth of this class of vehicle in the last six years has been extraordinary. At the end of 1904 there were two motor cabs in London; now there are well over 6,000, and this progress has been accompanied by an almost exactly corresponding decrease in the number of horsed cabs. In Paris the same rapid change has been taking place, and although the complete abolition of the horsed cab in provincial towns and also in colonial cities may not be quite so rapid, it is none the less certain. The period of apprenticeship of the motor cab was not as trying as that of the motor omnibus. The former, for the most part, is only a reasonable modification of the moderate-powered touring car, and there were not many new mechanical problems to be faced in its production. Neither does it seem likely that any very distinct type must be evolved for colonial use. It is undeniable that the rapid success of the motor cab is closely linked with the use of the taximeter, and it may fairly be said that the refusal of the horsed cabdrivers to adopt a reliable machine for registering the fare was a great assistance towards the progress of the motor. Naturally, there have been a certain number of complaints against taximeters on the grounds of accuracy. These, however, are in a great majority of cases unfounded. The writer has made a considerable number of road tests of taximeters of all the recognised makes, and the conclusion reached has been that, if the registration is not absolutely accurate, any error existing favours the public rather than the cab proprietor. This statement may be proved by taking journeys over distances which have been measured by the Metropolitan Police. It will be found that not infrequently the fare charged on the taximeter, registering both by time and by distance, is actually lower than the fare which would be paid if the measured distance only were considered, and the charge reckoned at 8*d*. per mile.

Vans and Lorries.—Turning to the trade vehicle proper, we find that progress has been arrested, more especially in certain districts, by reason of early failures. In many cases lack of success was due to the adaptation of unsuitable touring-car chassis to purposes for which they were never constructed. Even now one occasionally hears recommendations which will lead almost certainly to failure. Only a few weeks ago I read advice to the effect that second-hand touring cars fitted with suitable bodies would make good motor vans. In isolated instances, such experiments may have been attended with results which were far better than they deserved, but any so-called expert who could give general advice of this kind is fit only for an asylum or a reformatory, according to whether his expressed opinion is the result of sheer folly or of fraudulent intent.

Another factor which has tended to hold back the business motor vehicle was the formation of haulage and delivery companies, either operating with unsuitable vehicles or under inefficient management. Such concerns were not uncommon

in the early days of the industry, and a considerable amount of money was lost in them. Consequently we find deep-rooted prejudices still existing in certain defined areas. We are still not absolutely free from this kind of danger, for it is sometimes possible to formulate schemes which appear for the moment to be very attractive and far more likely to draw public support than more honest but less showy ventures. There is, of course, an enormous future for the genuine motor haulage and delivery contractor, and it is probable that the time will come when a very large percentage of the delivery work of great cities will be done by firms of this kind.

So far as the present position of the motor van and lorry is concerned, it will suffice to point out that huge fleets are operated by all the biggest retail stores in London and elsewhere in this country; that considerable numbers of vans are used for the carriage of mails, for which absolute reliability is the first essential; and that the motor ambulance, which must be at once smooth-running, speedy, and safe, bids fair to oust altogether the horse-drawn conveyance of the same class. It is doubtful whether there is a single well-known trade in which motor vehicles are not now employed, and the extent of their use is such that a variety of imaginary disadvantages—such as fears that perishable provisions would be injured by smell, or that fragile goods would be damaged by vibration—have died a natural death.

The Steam Lorry and Tractor.—The steam lorry and tractor have found their own spheres of usefulness almost entirely by a steady development along sound business lines. The satisfactory experience of one buyer has led to purchases by others in the same trade, and each vehicle has formed a centre around which business has grown up at a moderate rate, but none the less with certainty. The steam lorry is eminently suited for the carriage of loads of some five tons, with the addition of drawing, say, an extra three tons on its trailer. The tractor, while it has to depend entirely on its own weight for the adhesion necessary to draw its load, has the advantage that the load and the engine can be readily connected and disconnected. Thus, the engine itself can, by proper management, be kept almost constantly at work, while loading and unloading are still proceeding in the various depôts. The most recent development of the steam vehicle is in the direction of the smaller sizes. Whereas the petrol van has developed up from the light to the heavy, the steam lorry has made progress in the other direction, and the success of the five- or six-tonner has induced makers to turn their attention to the production of smaller machines, usually running on rubber tyres, and carrying two to three tons. About two and a half tons appears to be the lowest limit at which this class of machine can be advantageously employed. The steam lorry and tractor are essentially British productions, being to a great extent a natural development from the heavy road engine. So pre-eminent are British manufacturers in this particular branch, that steam lorries of English make are actually beginning to find a good market in France, where it might have been expected that the petrol vehicle would reign unchallenged. So far as economy is concerned, the steam lorry and tractor compare very favourably with any other class of motor vehicle, and—with the exception of weight of load—practically the only limitation to their use lies in the fact that they cannot carry a supply of fuel and water adequate for a very lengthy journey. In Great Britain itself this is of little consequence, but in some districts in the colonies it becomes important, and renders the production of a really economical and efficient internal-combustion tractor very essential.

General-Purpose and Agricultural Tractors.—It is a curious thing that while petrol-engined vehicles are to be found in all trades, and are in extensive use by fire brigades, municipal authorities, hospitals, and Government departments, their employment in connection with agriculture has up to the present been considerably restricted. This country is not ideal for the development of the agricultural motor and general-purpose farm tractor, which would find a readier market where land is not cut up into such small divisions. The great difficulty appears to be that a tractor with sufficient power to conduct ploughing operations at a reasonable speed in heavy land must necessarily be unduly powerful when applied to certain other subsequent operations, and it is extremely likely that its weight may be such as to make it undesirable to put it upon the land during the later stages of cultivation. The lighter class of agricultural motor is of considerable general use for farm purposes, and for driving stationary machinery, but its power is, of course, somewhat limited. Very diverse opinions reach this country as to what would really be the most suitable type of agricultural motor to meet the bulk of the colonial demand, and most British manufacturers hesitate to take up the proposition on a sufficient scale to lead to economical production

until they feel more sure of their ground. Up to the present the United States has favoured the heavier class of agricultural machine, but here, again, reports as to the actual results obtained are very conflicting. It would, I am sure, be of great interest to the British manufacturing trade if those who know the conditions of our great colonies well from personal experience would give their views on this question. For myself, I feel that, though some progress has been made, agriculture is the industry in connection with which the mechanical transport vehicle has at present reached the least satisfactory stage in its development. In saying this I do not refer specifically to the products of British makers, as I have reason to suppose that the attempts made on the Continent and on the other side of the Atlantic to solve this somewhat intricate problem have not been by any means wholly successful.

Section II.—Requirements of the Colonial Markets.

The question of special requirements is very closely linked with that of the relations between the buyer in the colonies and the manufacturer at home. As already mentioned, these relations have not always been of the sweetest, and it may be that traders in some branches have every right to complain of the dilatory methods of this country. However that may be, I cannot find sufficient evidence to show that it holds good to any reasonable extent in the particular industry under discussion. There have no doubt been a certain number of instances in which inquiries have not been treated with the full attention that they deserve, and in the early days of the industry there have doubtless been cases in which, owing to the rapid changes in design, manufacturers have been unable to supply promptly spare parts required for earlier models. We have, however, now reached a point of development when this last-mentioned difficulty should be practically non-existent.

The chief cause of ill-feeling appears to be that manufacturers are not disposed to produce a single vehicle embodying many features distinguishing it from their standard models. In some cases they may be wrong to discourage new business along new lines, but it is not always financially possible to deal with special requirements, and it is not unnatural that a manufacturer should attempt to meet peculiar demands by encouraging the purchase of more ordinary vehicles. In so doing, he is not merely consulting his own convenience, but the ultimate benefit of the purchaser. The standard model, though it may lack certain attributes, rendering it absolutely suitable for the work to which it is to be put, is at least the result of considerable experience and experiment. Every part of it has been tried and found good, and, though its utility may be limited in certain directions, it is probable that it will give better and more profitable service than a specially-constructed vehicle containing a number of purely experimental features.

Careless Correspondence.—If the manufacturer fails anywhere it is, in the opinion of the writer, in the details of his correspondence. To take a concrete example, a resident in British East Africa was recently anxiously inquiring for a suitable internal-combustion tractor for use in his district, and he was able to show that the demand for such a machine would almost certainly be very considerable. He was, however, troubled on one point, this being the question of whether special carburetter adjustment or design would be necessary if the tractor were obliged to work at very high altitudes above sea level. He laid particular stress on his wish for information on this point, but, in spite of carefully-worded inquiries, the replies received from home manufacturers universally neglected the one feature as to which he had doubts. This neglect is probably explained by the fact that the manufacturers themselves realised that the detail was comparatively an unimportant one, and that no real difficulty would arise in connection with it. Even so, the neglect to supply the information is inexcusable, and in this instance at least has led to the loss of the order, the purchaser having, somewhat against his will, decided upon a steam vehicle, which in many other respects he does not consider to be so suitable for his work. Instances of this kind seem to show that manufacturers sometimes devote the whole of their attention to the production of a first-class product, and allow the details of their sales department to be handled by inexperienced clerks, who are possibly only too anxious to get through their work in the minimum of time.

Quality of British Goods.—So far as the quality of British engineering products is concerned, there can be little or no cause for complaint in any branch of engineering, and in the motor traction industry there is absolutely no question whatever that the British market can supply the very best in all classes of industrial vehicle. Engineers who have ample experience of other countries as well as of Great Britain, and who are not biassed in any way, corroborate the view

that, so far as design and construction are concerned, this country has little or nothing to learn from the Continent, while the United States may for the present be regarded as altogether unproductive. This state of affairs will not, of course, continue; for the leading firms in the States are even now turning their serious attention to the heavier branches of the industry, and since they do not scruple to learn and adapt from British design, it is probable that, with their enormous outputs, they will become very real and serious competitors in the course of a few years. Even now the energetic business methods of American manufacturers suffice to plant cheap and generally shoddy American-built vans and lorries in many British colonies, and there is a distinct risk that the whole of the trade of Canada and the West Indies may ultimately go to the States on this account. It is, however, impossible to emphasise too strongly the real superiority of British-built vehicles over those of American origin.

Where the Buyer is at Fault.—Looking at the other side of the question, it will be seen that the potential buyer in the colonies is not altogether blameless if friction arises between him and the manufacturer. Certainly he knows something of his local conditions, but at the same time he generally knows little or nothing of the difficulties of engineering design. Consequently, he is only too apt to specify for an absolutely impossible combination of mechanical features, and to blame the manufacturer who will not quote him a reasonable price—or, still more likely, will not quote him at all—for a composite conglomeration of excellent designs and inventions which, considered as a whole, would be destined to immediate and undoubted failure when the vehicle is put into service. The British manufacturer, would as a rule, rather not do trade at all than do it in such a way as to create a bad impression of his products. He prefers to build up his business slowly and steadily by sound methods. To take an example on this side of the question, the corporation of a large town in a British colony invited tenders for a fire engine. The specification included diameter of driving wheels, ground clearance of mechanism, and a stipulation that the drive should be through a cardan-shaft and worm-gearing. The dimensions were such that a straight axle between the two driving-wheels would only just have had the necessary clearance from the ground, and no space whatever was allowed for the worm-gear and differential-gear and the casing containing them.

Buyers in distant countries should realise that a feature which may be good in itself is not necessarily good when it is imported into a design which was never intended to receive it. A Roman nose, in itself, is a more beautiful and possibly a more serviceable thing than a snub nose, but if it be put on to a face which was intended for the latter, the most beautiful Roman nose in existence will only be an æsthetic and practical failure. The same reasoning applies to the question under consideration.

Summing the matter up, the author would urge upon manufacturers at home to arrange that their correspondence should be fully and carefully dealt with by really competent men, who take proper trouble to study the letters for which their replies are intended. On the other side, he would beg all colonial buyers not to magnify the peculiarities of their requirements, which in ninety-nine cases out of a hundred are not really so different from those of other districts as to necessitate the construction of a special type of vehicle, or the embodiment of alterations very expensive both in time and in money.

Ground Clearance.—One of the principal points in which deviation from standard design is necessary, in order to cater successfully for colonial trade, is ground clearance. A clearance of, say, ten, or even eight, inches may be ample for a three-ton lorry or passenger conveyance for use at home, working exclusively—or almost exclusively—on made roads of fairly good quality. In younger countries, however, this is often insufficient in view of the rocks and tree-stumps projecting above the surface of the track. This track consisting frequently of little more than two deep ruts, the effective height of such obstructions is increased, and they become very dangerous to the mechanism. Further, it often happens that at certain seasons the ground becomes very soft, while in other districts sand abounds. In either case wheels sink deep, reducing the ground clearance of the mechanism. Then again, fords may have to be crossed, so that the engine must be placed high.

Big Wheels—Clearly, the simplest way of overcoming the difficulty from a mechanical point of view is by the adoption of big wheels with wide treads. The latter assist in preventing the vehicle from sinking in soft or sandy places, and at the same time reduce the loss of power, which is always an important factor when the wheels are perpetually climbing uphill out of the cavities into which they have sunk. The increased width gives a larger area of contact with the ground, and reduces the intensity of

pressure, and consequently the depth of the rut formed.

An increased diameter of wheel has a similar effect, but at the same time it levels out the smaller depressions in the road surface, and makes for easier riding, so rendering higher speeds possible without undue jolting, which is a source not only of discomfort to passengers, but of damage to mechanism.

In a self-contained vehicle the provision of big wheels is not, however, quite so simple a matter as might be imagined. For one thing it entails a further gear reduction between engine and driving-wheels, and this may not be compatible with sound design without the introduction of an extra reduction gear. There are limits to the reduction which can be advantageously effected in one step. For example, in the case of a chain-driven machine the maximum size of the chain-wheel is limited by the necessity for keeping the chain well clear of the ground. This limit being reached, the reduction between the sprockets on the cross-shaft and the chain-wheels can only be increased by reducing the size of the sprockets and the number of teeth upon them. If this reduction be taken too far the effect of the action of the rear springs is to cause uneven propulsion, rapid wear of sprockets and chains, and even undesirable stresses as far forward as the clutch and possibly the engine itself. This difficulty of gear reduction is, however, not insuperable, since a modification of differential or change-speed gears, and possibly the introduction of an extra reduction gear, will attain the desired object. The example is given rather to show that when extra big wheels are specified the manufacturer has not merely got to take off his standard wheels and put on larger ones, but may very likely be put to expense never contemplated by the intending user, who naturally enough resents any considerable increase in the price of the vehicle.

Loading and Unloading.—Assuming, however, that the difficulty of gear reduction has been overcome, the manufacturer is still liable to get himself into trouble in his efforts to please, for the purchaser—if the vehicle is for the carriage of goods—has almost certainly stipulated for ample platform area or body capacity. This can, of course, be provided, but a four-inch rise of the axles and mechanism—giving a clearance of fourteen instead of ten inches—means an eight-inch increase in the height of the wheels. Thus, if the platform or body floor has to be kept low, it must be sunk between the wheels and its width is much curtailed, while the lost space cannot be made up in length without producing an unwieldy and possibly dangerous vehicle. For this reason the platform is probably extended over the wheels at a much greater height than usual, and when the waggon reaches the purchaser the maker is blamed for supplying a vehicle which is by no means convenient for loading and unloading. A van body may be recessed over the big wheels without sacrificing a great deal of space and without raising the floor more than enough to clear the mechanism, but even in that case the centre of gravity of the loaded vehicle has been raised, and it may become top heavy and unsafe on winding and hilly roads.

Passenger vehicles of the char-à-banc or waggonette type can be provided with big wheels without these disadvantages making themselves severely felt. In the waggonette or omnibus the wheels may occupy part of the space beneath the seats, and in the char-à-banc the body usually tilts upwards towards the back to give the passengers a better outlook, and large driving-wheels are consequently no great inconvenience, while they certainly contribute enormously to comfort at fairly high speeds.

In the goods vehicle, as has been indicated, it is far more difficult to reconcile the various requirements, and it is best to compromise as far as possible. In other words, the clearance stipulated should not be in excess of that actually needed, and it is better to avoid one or two bad routes and incur additional mileage than to suffer continual inconvenience in loading, or to put up with a greatly-reduced platform area.

Good results may in some cases be obtained by stipulating for big wheels and high platform, with some mechanical means of assisting loading by the power of the engine, or with detachable bodies which can be slung into place on the platform when fully loaded.

In extreme cases, where very large and wide wheels are absolutely essential, the independent tractor is the only possible solution.

Water Supply.—Of no less importance as a feature of colonial vehicles is adequate provision for completing long journeys without taking water. A well-known expert on military transport once gave the author a South African traction driver's definition of water:—

"If you put stuff into a bucket, and if you turn the bucket over, and it falls out, it's water; if it doesn't, it's mud."

The same authority advised on watering tractions as follows:—

"Stuff of the consistency of tea or cocoa is

very welcome. Green, stagnant water is to be avoided. Most of the other colours can be passed."

In many districts the shortage of water at certain periods of the year, or the lack of an available supply convenient to the roads at suitable intervals, constitutes a serious bar against the use of steam lorries or tractors of standard types. The difficulty can be partially, but not completely, overcome by the fitting of specially large water-tanks, but these cannot at the best be of such dimensions as to remove altogether the risk of shortage. This, together with the bulkiness of coal or wood fuel, is the principal incentive to the production of the internal-combustion tractor for agricultural, general, and military purposes. Such a machine can be designed to run, say, a hundred miles under full load without replenishment of tanks.

In connection with the internal-combustion engine, water plays a minor but still an important part, and the climate of tropical countries makes it frequently necessary to introduce modifications in design, with a view to increasing the efficiency of the cooling system. Radiators, pipes, and cylinder jackets must be of very ample dimensions, and the thermo-syphon system of circulation, which is often quite adequate in temperate countries, will not suffice—at least for the heavier classes of vehicle—in very hot climates. To get high thermal efficiency, the water must not be too cool when it leaves the engine, and for this reason it would not be advisable to make standard models suitable, in this respect, for use in the tropics.

Other Modifications.—Colonial buyers may reasonably be very firm in their stipulations for high ground clearance, and for efficient cooling or adequate water-tanks, as the case may be. Other changes from standard models introduce further additions to the price of the vehicle, but may occasionally be necessary or worth the extra cost. For example, the right wheel gauge, and equal gauge of front and of back wheels, are important where roads consist mainly of tracks with two deep ruts worn by a certain class of traffic. Then, again, where sand is abundant the mechanism must be very effectively protected, and a transmission adapting itself to this is to be preferred.

Some buyers may insist upon two entirely distinct ignition systems; others may feel that a winding gear and wire rope is an essential; others, again, may want special mechanical devices to assist in rapid loading and unloading. The real utility of every such desirable feature or adjunct should be carefully considered in relation to its additional cost. From an economical standpoint it is foolish to draw up a kind of ideal specification to which no manufacturer can tender, except at an abnormal price. The spirit of compromise must enter into this, as into other matters of business, and a good deal of confidence may be placed in the fact that a really first-class manufacturer prefers ultimate success and increase of business to quick profits and final failure, and so will always endeavour to supply what will really give satisfaction.

Wheels and Tyres.—Steel wheels are more suitable than wood in tropical climates, but the latter have more "give" in them, and provide a softer drive and a certain amount of immunity from vibration. Solid rubber tyres do not wear so well in very hot countries, but in temperate climates—leaving legal restrictions out of the question—they are a positive economy, owing to the protection which they afford to the mechanism. For very light and fast vehicles even the pneumatic may be justified for the same reason.

High speeds without some resilience in tyre or wheel mean high repair bills, and there certainly seems to be a big field in tropical countries for an efficient and reliable resilient wheel. In cold climates, where snow abounds, winter wheels with composite treads should always be kept available for use on waggons or tractors which run normally on steel tyres. It is doubtful whether the solid rubber tyre can be used with economy when the load is drawn instead of carried, but its employment can be confidently recommended under anything approaching normal conditions on all self-contained vehicles carrying loads up to about six tons. Buyers who stipulate for big wheels should remember that the first cost of their rubber tyres will probably be considerably higher, but this does not imply that the tyre cost per mile will be increased. In fact, tyres of big section, or big diameter, or both, generally prove the most economical in the long run.

The Question of Fuel.—For steam vehicles the best fuel is a thoroughly good grade of steam coal, but cheaper grades of coal and also coke may be used with perfectly satisfactory results on steam waggons and tractors. In districts where coal is not available, or only obtainable at an exorbitant price, wood may be quite easily used, provided that the fire-box is specially constructed for the purpose. The author does not at present recommend the use of oil fuels on standard steam waggons and tractors. Various

systems have been worked out, but have not yet reached a point where they can be advantageously put into the hands of drivers with no great mechanical experience.

As regards the fuel for internal-combustion engines, petrol is undoubtedly the most suitable, wherever it can be obtained at a reasonable price. The cheaper and heavier grades of petrol are absolutely satisfactory, and in many countries the price of these spirits is so near to that of paraffin that there is no reason to consider the use of the latter. Benzol would undoubtedly be a real competitor of petrol if it were available in sufficient quantities, but it does not seem likely that alcohol will be of great service for a considerable time to come, experience pointing to the conclusion that it must be used only in a mixture with benzol or some other fuel, and that the more alcohol is present in the mixture the less satisfactory are the results obtained. Paraffin is very little used in Great Britain, or any other temperate countries. It is difficult to get an engine to start up from cold on paraffin, and the fuel undoubtedly soots up the cylinders rather rapidly. In tropical countries, paraffin is very successfully used without any very expensive means of adapting the engine for the purpose. There are plenty of examples of motor vans, driven by natives, using paraffin and giving very reliable service.

Section III.—Suggestions for Accelerating Trade.

Colonial and Military Transport.—Up to this point I have endeavoured to show that there is an enormous field for the development of motor traction in Greater Britain, and I have also attempted to dissipate some of those misunderstandings which I believe tend to hold back the inevitable increase of trade. It is desirable, however, that something more should be done than merely to give the trade a reasonable chance of growth, and, if possible, it would certainly be well to afford it some measure of active encouragement. With this object in view, I propose finally to outline one or two suggestions which, I think, are worthy of consideration.

Those who are substantially in agreement with me as to the nature of colonial requirements will probably also agree that, to a great extent, a compliance with these requirements would produce a vehicle eminently suited for military service in connection with transport and supply. Both in France and Germany extensive schemes are in operation, under which trials of industrial motor vehicles are held annually under Government auspices and supervision. As the result of these trials certain types are stated to be suitable for military use, and purchasers of vehicles of these types are granted very substantial subsidies, both at the time of purchase and also annually, for a certain period. In Germany £200 is allowed towards the purchase price of a vehicle of a type duly tested and approved, and this is followed by an annual payment of £50 for five years, provided that the vehicle is maintained in first-class condition. The lorries favoured in Germany are of considerable power, and carry loads of about five tons.

In France the three-tonner is specially favoured. An initial subsidy of £100 is paid on purchase, this being followed by payments of £50 per annum for three years, subject to proper maintenance. The subsidies payable on two-tonners are £80 on purchase and £40 per annum. Somewhat similar schemes have been completed, or are under consideration, by the War Offices of other countries, as, for example, Austria.

In Great Britain some attempt has been made to work on rather similar lines, but up to the present the Treasury has not sanctioned any sufficient grant to the Mechanical Transport Committee to allow of a reasonable subsidy being paid to the owners of suitable vehicles. Consequently, the annual payment is at present merely nominal, though it is augmented to a slight extent by payments for hire at a moderate rate while the vehicles are in actual service.

That the whole scheme requires revision has been proved beyond a doubt, as has also the extreme utility of motor traction in connection with the transport and supply of armies in the field. At the conclusion of the recent military manœuvres in this country, Sir John French, in his official capacity, said:—"The present system of supply and transport will soon be greatly modified by the introduction of mechanical transport on a larger scale." Then again, the military correspondent of the *Times*, after a careful study of the conduct of the manœuvres in France, wrote:—"The supply of the Third Army Corps by a service of motor lorries formed one of the most interesting features of the Picardy Manœuvres. The time has now fully come for drastic reorganisation of transport and supply between armies and their rail-heads. The French, foremost as usual with new ideas, have given us a clear indication of what we have to do."

Subsidies for Colonial Models: a Suggestion.—In view of the urgent need for the production

of a large number of vehicles suitable for military use, the question naturally arises whether the similarity between colonial and military requirements cannot be in some way utilised to assist toward the desired end. The subsidy, if it is to be attractive, must be sufficient to cover all additional expense entailed by the owner of the vehicle and to leave him with a margin of profit. If, in order to obtain the subsidy, he must purchase a vehicle which is not of a standard type, and is therefore expensive, the subsidy itself must be increased to cover the extra cost. By encouraging the demand throughout the British Empire for vehicles of suitable types, a supply of these vehicles will automatically become available at a moderate cost, and all their parts will be standardised, and spare parts readily obtainable in quantity. When this point has been reached, it is probable that many users in Great Britain itself would have no objection to employing the colonial type of vehicle, if the War Office could offer them some return in the event of their doing so. Thus a home demand might be brought into existence which would give an increased output of these types and still further decrease their cost. Finally, the subsidy which would have to be paid would not be very great, and a really suitable and adequate fleet would be at the disposal of the British War Office whenever it might be required for operations in or near this country. Such a fleet would also, if necessity arose, be capable of being effectively used in almost all parts of the globe, and even in countries in which the road system is by no means fully developed.

It seems, however, that it would certainly be extremely useful if a nucleus of a suitable fleet were available locally in each of our more important colonies. There is at present a strong tendency throughout Greater Britain towards some form of national service, and colonial Governments are willing and even anxious to assist in the defence of the Empire as a whole. Would it not then be a wise action on the part of these Governments if they were to consider offering a reasonable subsidy to encourage the use of suitable motor vehicles in their territories, these vehicles being available for manœuvres, and also in case of war? The cost of carrying out such a scheme on a sufficient scale would not be at all high, and the result would be not only the production of a mechanical transport column for military purposes, but it would also constitute a powerful incentive to the general development of mechanical transport, and consequently would tend towards the material improvement of the internal communications of those colonies the Governments of which saw fit to adopt a subsidy scheme. The matter is one for the discussion of which the next few months will offer unrivalled opportunities.

If this suggestion be deemed worthy of consideration, I think it will be found that there are not many real difficulties in the way. The subsidy would, of course, only be granted to vehicles obtainable from the British market, or manufactured in the colonies themselves. Periodical organised trials might be held in Great Britain if it seemed desirable, but in all probability this course would not be necessary, as certificates could be granted to makers in respect of certain suitable types after individual trial and inspection by a committee, which might with advantage be composed partly of military and partly of civil experts. If it were understood that the vehicles of types subsidised by colonial Governments would be given first claim to subsidy by the British War Office itself, there would be a powerful inducement to manufacturers to turn their attention to the production of suitable types in sufficient quantities to ensure distribution at reasonable prices, and adequate standardisation and interchangeability of parts.

As things are at present, it cannot be expected that a user in Great Britain would, for example, go to the expense of fitting extra tanks, or incur the inconvenience following upon an exceptionally high ground clearance, unless he could see some definite advantage following naturally upon the expenditure or trouble. Consequently the colonial demand stands alone, and, so long as it is insufficient to provide for considerable outputs by manufacturers, the price of special vehicles must necessarily remain rather high, and the number of machines really suitable for military use must continue to be comparatively small.

It seems to me that, by adopting the suggestion outlined above, colonial Governments might afford real assistance towards the defence of the Empire, while at the same time benefiting both in the matter of their own local defence and also in the general development of their trade and territory. These possibilities should not be forgotten by Government officials when questions arise as to the establishment of light railways, tramways, or road motor services. The last-named are adequate for moderate traffic, and when they have been the cause of extending that traffic to sufficient dimensions, light

railways can be constructed and the road vehicles can be transferred to other less developed districts. By this process the roads grow almost automatically, and an essential element of progress is thus assured, while the colonial Government is continually in possession of the valuable asset of military transport, not limited in its use—as is a railway or tramway—to the specific district in which it chances to be usually located.

A "Coronation Review."—In conclusion, I should like to put forward one more suggestion which may, perhaps, be considered trivial, but which at the same time is another means towards the desired end. In view of coming events, London will, in the course of the next few months, see an influx of an enormous number of very influential legislators and business men from every territory in the British Empire. Many of these visitors, while business may not be the first object of their stay in this country, will not neglect any real opportunity of learning more of any means which may be offered to assist in the development of Greater Britain. Consequently it would, I think, be well worth while to organise a review of a representative collection of industrial motor vehicles from the British market, and to arrange for this review to take place on a day during, or as near as possible to, the week of the Coronation. An event of this kind would be most effective if it were judiciously limited both as to time and also as to extent. I do not for a moment suggest that a heterogeneous collection of all sorts and conditions of motor vehicles should be gathered together from every available quarter. The fact that mechanical traction is used in all trades will be obvious enough to visitors who keep their eyes open in the London streets. What would, I think, appeal to them far more would be a carefully-organised exhibit in which all the leading types were represented in strictly moderate numbers, special prominence being given to designs which appear to be, or have already shown themselves to be, suitable for use in countries where the road systems are not as yet fully developed. The review would not be limited in its interest to the mechanism of the vehicles, as by careful organisation it would be possible to ensure that the coachwork, the wheels and tyres, and even the fittings and accessories, were representative of a wide range of utility, and of the latest improvements and refinements. It would be possible, in a gathering of not more than forty or fifty vehicles, to show very clearly and concisely what the British market has to offer Greater Britain as an aid to the improvement of internal communications. An hour or so spent even in a merely casual inspection of the vehicles reviewed would leave a lasting impression of the ability of this young industry in Great Britain alone to meet all the requirements of the British Empire, and would help to counteract any false impressions which may exist, and any tendency to neglect the Mother Country in favour of others which, in point of fact, have not reached anything approaching the same point in the development of the utility motor vehicle. I have little doubt that, given the support of the leading firms in the manufacturing trade, it would be possible to get together a committee of very great influence, which would ensure that proper publicity should be given to the whole scheme, and that very many of the more prominent visitors to London should avail themselves of the opportunity of inspection offered. The author has already taken steps privately to obtain opinions as to this proposal, and up to the present his suggestions have, on the whole, been very favourably received.

Until the horse has been ousted from the streets altogether, a really adequate impression of the tremendous progress made by motor traction will not be obtainable in a convenient and impressive form, except by some such demonstration as that suggested, and it would, I think, be most unfortunate if we were to allow all these visitors from our colonies—men whose influence will be widely felt in their own territories—to leave this country without being shown that, in the all-important matter of road transport, Great Britain is fully prepared to meet their needs. This proposal for what might be called a Coronation review of industrial motor vehicles has already made some real steps towards fulfilment, and the author would welcome suggestions and support from those who are able and willing to help in the furtherance of the scheme.

In concluding what I fear has been an unduly lengthy paper, the only apology I can offer for so far taxing the patience of my audience is that I have attempted to touch upon a subject the importance of which I feel very deeply. It is impossible to overrate the value of facilities for communication. They are at the bottom of the whole fabric of civilisation, and constitute a power which, if it is properly applied, can help in no small measure to consolidate the British Empire, to strengthen its defences, and to augment its trade.

APPENDIX.

NOTES ON TRADE OPENINGS IN GREATER BRITAIN.

ASIA.

The Indian Empire.—The principal factors operating against the development of mechanical transport in India are officialdom and native lack of enterprise. As regards the first, it is frequently difficult to further any new project without abnormal delay and complicated correspondence. The other difficulty is due to the fact that the natives do not set much value on time, and are quite satisfied with the speed of their primitive forms of transport, which can be operated at a very low cost. There is also a disinclination to subscribe capital for progressive ventures, and foreign capital consequently has to be employed in most cases where schemes of any size are contemplated.

From a series of reports prepared by executive engineers and other qualified residents, and subsequently transmitted to the Colonial Office, it appears that motor traction would be beneficial to a great part of India. Generally speaking, one gathers that the districts where a demand is most likely to spring up are those within a radius of some 400 miles of Bombay. At the same time numerous favourable reports are received from districts in the Punjab, the United Provinces, the Southern portions of Madras, and the neighbourhood of Calcutta. Up to the present, development has been arrested by the failure of early experiments, which were frequently made with unsuitable second-hand vehicles quite unfit for the work, or else with touring cars carrying excessive loads of goods or passengers. There has been a recovery during the last year or so, and prospects of development have improved.

If it were possible, one of the best ways of developing motor transport in India would be through the medium of the railway companies. There are many districts where traffic is insufficient to justify a branch line, and where a motor service would yield a good return independent of any benefit to the railway itself. The whole scheme might with advantage be developed in conjunction with military transport. In addition to road vehicles, the railways would probably find it advantageous to adopt rail motors for light traffic and also for inspection work. In the towns, motor traction might well be used for the cartage of refuse and for the watering of streets. In some districts passenger motor services might be made to pay if catering for European traffic. The rates at which natives travel are so low that ordinary passenger vehicles would not pay if run for their benefit. The only possibility in this direction appears to be the use of tractors, drawing one or two trailers with ample seating accommodation. These would not give a high speed, but from the natives' point of view the defect is of little consequence. Touring cars might be extensively adopted by Government officials as a means of saving travelling expenses and economising time on cross-country routes.

As regards fuel, the price of coal varies very much in different districts. It is extremely cheap near the mines, but may be very expensive in more or less inaccessible districts. The quality of the coal is also variable. Water is usually abundant, so that there is no bar to the use of steam vehicles. Both petrol and paraffin are available, the price of the latter being distinctly low. Internal-combustion vehicles should have large radiators and adequate cooling systems on account of the hot season.

On the subject of the possibility of the general use of motor traction in India, Captain E. N. Manley, R.E., in a report on "Mechanical Road Transport for India," published by the Royal Engineers' Institute, wrote:—"As regards climbing steep roads, the modern motor vehicle can go wherever a horse or bullock-drawn cart can work . . . For haulage of loads not requiring a greater speed than five miles per hour, the cheapest form of motor is the steam lorry, tractor, or traction engine . . . Many traffic routes, such as are worked by the railways as out-agencies with bullock-cart services, should be workable by mechanical means."

Calcutta.—Turning to specific districts, the development of mechanical traction in the neighbourhood of Calcutta has not, up to the present, been rapid. The Calcutta Port Commissioners use petrol vans, and the East Indian Railway have several steam and petrol vehicles. Various mills have also been experimenting. A motor omnibus service was tried in Calcutta, but without success, and it is too early at present to predict the future of the taxicab movement in that city. Up country there are a certain number of internal-combustion lorries and passenger vehicles generally giving satisfaction, and there is little doubt that a considerable demand for fairly light vehicles of this class is bound to arise sooner or later, both for passenger work and also for the carriage of goods.

Bombay.—As the whole district around Bombay appears to be suitable for mechanical transport it may be worth while to deal at some length with this centre. As elsewhere, early attempts were made to utilise pleasure cars for commercial purposes, and unsuitable vehicles were tried for omnibus services, and subsequently for goods work. The repeated failures of these vehicles, which changed hands from time to time, gave the impression of a large number of unsuccessful machines, where, as a matter of fact, only a few existed. Many of the cars were second-hand when they reached Bombay. During

the last two years steady progress has been made. Both the railways serving Bombay use parcel delivery vans, and a service of petrol electric omnibuses has recently been started in the Poona district. Petrol lorries are also used to a certain extent by private concerns. Up to the present the principal difficulty has been the maintenance of tyres. The cab services of the Indian Taxicab Co., and of Messrs. Hill, Sawyer and Co., are well patronised, but nothing definite can be said yet as to their ultimate financial success. Steam lorries and tractors are finding increased favour for the transport of goods. In Bombay itself there are now about a dozen steam lorries of various makes in service. The municipality and others employ steam tractors. There are also one or two traction trains, but it is stated that there are complaints against the noise and vibration of the heavier machines. There is undeniably a good opening both for passenger and for goods services. The light railways cannot cover the ground completely, and many of the towns are more suitable for road vehicles than for electric tramways. For passenger purposes, bodies of the single-deck omnibus type with accommodation for as many passengers as possible, and with divisions into classes, would probably prove most suitable. The price of commercial petrol is so near that of the better grades of kerosene that it does not seem necessary to attempt to use any but the former as fuel. Petrol was recently quoted at 12 annas to 1 rupee per gallon in various parts of the Presidency; high-grade paraffin at about the same price. In Bombay itself commercial petrol costs 10 annas, and the ordinary kerosene 8 annas per gallon.

For goods services, steam vehicles seem to be very suitable. The price of coal varies in the Presidency from 12 to 20 rupees per ton. Wood costs from 5 to 10 rupees, according to quality. Near the mines coal can be obtained at a ridiculously low price. There is plenty of water, except in a few very mountainous districts. The town roads are in good condition, but the district roads, though metalled, are not very suitable for heavy traffic. The principal difficulty is in the existence of bridges and culverts, which are only safe for quite light roads. When existing bridges are strengthened, most of the roads will be suitable for all kinds of motor traffic, at least in the dry season. Gradients are easy in the northern parts of the Presidency, but steep in the southern parts, where the roads, however, are harder and better. As regards local requirements, engine power should be ample, as also should be ground clearance. Wide tyres are advisable on steel-tyred vehicles. Native drivers of steam or petrol vehicles can be obtained at 50 to 80 rupees per month, but these men would not generally be capable of undertaking serious repairs. At present there are no adequate repair shops except in Bombay City, and even there the charges are, as a rule, very high. This difficulty will decrease automatically as the number of vehicles in service goes up. It is stated that at present local capitalists are shy of motor transport schemes, while Government favours light railway and tramway projects.

Ceylon.—It appears that road and other conditions make Ceylon very suitable for mechanical transport, but that the attitude of the Government has up to the present retarded development to no slight extent. The Government has contemplated starting services itself, but this intention appears to have been almost abandoned. Meanwhile, private enterprise is not given a free hand. A suggestion has been made that the money which was to have been devoted by Government to the purchase of vehicles should go to the improvement of the roads, and that a charge should be levied for every ton of produce carried by motor traction over the roads where the improvements have been made. It also seems that the Government may retain control over the rates charged for goods and luggage. As there appears to be an admirable field for motor traction in the island, it is to be hoped that all obstacles to development will be removed in the near future.

The Federated Malay States.—The Federated Malay States Railway owns a large fleet of motor vehicles mainly used for the carriage of passengers. The fleet appears to be, at present, in excess of the requirements of the services, and consequently only a comparatively small percentage of the vehicles are kept regularly running. In spite of this, the services would show a profit if it were not that an enormous allowance is made for depreciation. With reasonable allowance under this head the venture would certainly be a financial success, considered independently, and without allowing for the beneficial effect which it must have upon the railway passenger service.

There are also a number of private companies running passenger vehicles, principally used by coolies. These vehicles number perhaps twenty or thirty. There is an opening for a few taxicabs in the larger towns. At present ordinary touring cars are used for hire purposes. European engineering firms and also mineral water manufacturers already use motor lorries and vans. Petrol is produced in Sumatra, and costs about 1*s.* 6*d.* per gallon when purchased in large quantities. Paraffin is cheap and obtainable anywhere. Coal is dear and mostly imported; wood is obtainable anywhere. An engine using paraffin as fuel would be very suitable in the Malay States, but there is no difficulty about operating steam lorries, etc., provided they use wood fuel, as water is plentiful.

The roads are good, but somewhat narrow. The country in the interior is mountainous, but the gradients are not severe, being generally about one in thirty for long stretches. The

corners are very sharp. Standard English cars are used in the Federated Malay States, and there do not appear to be any special local requirements in the matter of design. Native drivers are available at £3 to £5 a month. There is at present a scarcity of good mechanics for repair work, but garages are gradually being started under European supervision. Charges for repairs should be reckoned as somewhat higher than in England.

In comparison with many Continental countries, including France and Austria, the Federated Malay States are ranging well to the front in matters relating to mechanical traction, although bullock haulage is very cheap.

Aden.—The territory of Aden offers a very limited field for motor traction. There is a service of single-decked passenger vehicles in use on what is probably the only possible route. Owing to the great heat, the upkeep of wheels and tyres is an expensive matter. Drivers and mechanics have to be brought from Bombay. There is no water except that which is condensed, and sold at about 3*s*. per 100 gallons.

AFRICA.

The requirements of British possessions in Africa cannot be dealt with in the lump, owing to the difference of conditions in the various colonies. Generally speaking, on the West Coast of Africa, and also in Uganda and British East Africa, there are a very limited number of roads, but where roads exist at all they are of reasonably good quality. The opening for motor services is almost entirely for the carriage of produce from the interior to the coast or to rivers. In Southern Nigeria there is a motor service operated on a considerable scale by the Government. No difficulty is found in using paraffin fuel, which can be obtained at something under 1*s*. per gallon, while petrol is extremely expensive. This use of paraffin is particularly interesting, as the vans are all handled by natives, who are not only cheaper than Europeans, but are able to stand a reasonable day's work, whereas European drivers are very rapidly tired out by the climate. Throughout the East and West African colonies there are many districts which do not justify the construction of railways, where motor services are now operated, and will doubtless be used to a much greater extent than at present. These services are responsible for the mails as well as for the carriage of goods. In East Africa there is also a demand for a really good internal combustion tractor for general agricultural and haulage work. Here, as in many other parts of Africa, cultivators are very dependent upon their beasts, and any epidemic among the animals is consequently liable to prove very ruinous. A great part of South Africa has similar requirements in the matter of agricultural motors, and many of the less developed districts are not sufficiently advanced to encourage motor traction in any other form at present. This does not apply to the principal towns in United South Africa, where the usual developments may be expected. Probably the best centre from which to distribute through British South Africa generally, and which would also be reasonably convenient in view of the probable extensive demand for improved road transport from the mining districts, would be either Johannesburg or Pretoria. Consequently some detailed particulars are given as to the local conditions prevailing in these two towns.

Johannesburg.—In Johannesburg itself the South African Railways use steam waggons extensively for the haulage of general merchandise, and several cartage contractors own similar vehicles. Many of these waggons are used principally for hauling instead of carrying, taking very heavy loads on two trailers with excellent results. Motor cabs are used to a considerable extent in Johannesburg, about seventy-five being licensed. They are, in fact, rapidly taking their place in all the principal towns of South Africa. There appears to be a very good opening for all classes of trade vehicles, and there are numerous inquiries for agricultural motors, a certain number of which have reached the district lately.

Some correspondents recommend paraffin as the most suitable fuel, as coal and wood are stated to be scarce and dear in many parts. Paraffin costs 12*s*. 6*d*. or 13*s*. per case of eight imperial gallons. In Johannesburg itself coal is obtainable at about £1 per ton, but in outlying districts it is very much dearer. In the neighbourhood of the town itself there is plenty of water, but in some districts it is very scarce during the summer. There is, however, generally enough to make the use of steam vehicles possible. The roads round the principal towns are generally good. The roads in the veldt are merely bullock-waggon tracks across country which is sandy in places and clay elsewhere. In some districts the tracks are very level, but in places gradients up to one in five are encountered.

As regards local requirements, there should be ample margin of power to negotiate bad places. The ground clearance should be as high as possible, eighteen inches being advised for the outside districts. The steering lock should be ample, and chain steerage is recommended for the steam waggons and tractors. For the heavier classes of vehicle, metal tyres are generally the most suitable, and solid rubber for express work.

As regards labour, there is plenty of raw material, and a sufficiency of skilled drivers is to be had round the towns. There are plenty of repairing shops in the towns, but drivers are generally expected to do their own repairs. In the country districts repair shops are very scarce. The wages of trained drivers are somewhat high.

Touring cars are well represented in the district, but representatives capable of pushing the sale of industrial vehicles are very scarce. Actual demonstration on the spot will have more effect on the development of the industry than any other method.

Pretoria.—It is stated that there is a great future in the neighbourhood of Pretoria for lorries carrying about two tons, and it is suggested that road trains of suitable design would also be successful. Prejudices exist against traction engines, which might also operate against steam tractors, but steam lorries would do well, provided that their boilers are adapted to use water of bad quality. The roads are good in the town, but indifferent in the suburbs and very bad outside. In some places there are patches of black turf which, after rain, sticks to the wheels, completely clogging them. Even the ox waggons sink up to the axles in these places and have to be dug out. These conditions only prevail between the months of November and March. There are also patches of sand often six inches deep, the sand being very loose and shifting. The road clearance should be as great as possible, fifteen inches being none too much on account of boulders in the roads. Also rivers two feet deep may have to be crossed. Round Pretoria the roads are fairly level, but on account of the dongas (dry rivers) occasionally encountered, all vehicles should if possible be fitted with rope-winding gears. Large radiators are advisable, and these should be amply protected, as native drivers of horse traffic are very careless and collisions are not infrequent. Ignition should be by magneto, and might be duplicated. Paraffin costs about the same as in Johannesburg, but petrol is about 50 per cent. more expensive. Arrangements should be made for extra air supply to carburetters, owing to the high level of the land, both Pretoria and Johannesburg being over 4,000 feet above sea level. Steel wheels should be fitted, and, owing to the difficult pieces of ground encountered, a very low first speed and reverse are recommended.

AMERICA.

Canada.—Leaving on one side the enormous potential demand for agricultural implements throughout a wide area of Canada, the most promising fields for motor traction vehicles of various classes lie on the one side in the Provinces of Quebec and Ontario, and on the other in British Columbia. There is already a big demand, which will increase still further, in the Canadian cities on and near the St. Lawrence, and the greatest obstacle to British trade in this district is likely to be the severe competition of American products, which, though not of the same quality, are obtainable at a low price. Both here and in the neighbourhood of Vancouver a limited number of British manufacturers have cultivated trade with admirable results, and their example might well be followed by others, prompt action being necessary if this very valuable territory is to be available for the output of British trade.

Ottawa.—As examples of which some particulars may be given, we may take Ottawa and Vancouver as typical of the leading Canadian towns. The possibilities of trade in Ottawa are very great. There is room for a quantity of taxicabs, a number of large omnibuses or chars-à-bancs for sight-seeing purposes, and also for smaller omnibuses running country services, and combining the duties of a passenger carrier with those of a Royal mail. Services of this sort can operate from city to city, and the same applies to vehicles for the carriage of light merchandise. There is also a demand for vans or lorries, from one to five tons, for use by traders of all sorts, and the general demand, already big, is rapidly increasing.

The price of petrol varies from 15 to 20 cents per gallon, and this fuel is almost exclusively used, though there appears to be nothing to prevent steam tractors and lorries from being also employed with advantage. In the Province of Ontario the roads are mainly macadam, the remainder being gravel, and the surface is on the whole fairly good. In the Province of Quebec the chances of development are not so good, as there are fewer roads, and these of a lower quality, making them unfit for heavy traction except in the height of summer. There is, however, a strong movement in favour of better roads, and the next few years will doubtless see great improvements.

As regards special requirements, ground clearance should be not less than twelve inches, and wheel-gauge should preferably be the standard 4 feet 8½ inches. Drivers and mechanics are available, but wages are high, and there are good openings for responsible and sober men from Great Britain. Drivers get from 12 to 25 dollars per week and repair men from 20 to 25 cents per hour. Good mechanics get as much as 30 to 35 cents per hour. Generally speaking, British manufacturers, with the assistance of the preferential duty, should be able to hold the field for the higher classes of mechanically-propelled vehicle.

Vancouver.—In British Columbia the demand is principally in the district of Vancouver and Victoria. In the neighbourhood of the latter there are steep gradients and rough roads, and many of the bridges will not carry more than about three tons. The principal haulage is lumber and cord wood.

Quite a number of industrial motor vehicles are in use in Vancouver, and their employment is increasing rapidly. These vehicles are of all kinds for light and heavy loads, and are used by retail and wholesale firms, and also by the city scavenging and fire departments. Those of the best makes have proved very economical.

Vancouver is stated to have more motor cars in proportion to the population than any other city. These include chars-à-bancs, hotel omnibuses, taxicabs, lorries, and vans of all kinds. Petrol-driven vehicles are principally employed, but water would be available for steamers. The roads are not good at present, but are being gradually improved, and gradients are not exceptional.

As regards local requirements, a good clearance is favoured, but is not absolutely essential. A low-built waggon for heavy work is in demand. This would have the floor of the body brought down very low to avoid lifting of heavy goods. Efficient labour is available for driving and repairs.

The trade in British vehicles is greatly affected by the cheapness of some of those supplied from the United States. Consequently first cost is an important consideration.

WEST INDIES.

There are several good openings for mechanical transport in the West Indies. Without attempting to deal separately and completely with every British possession in that part of the world, it may be said that motor traction is already finding a footing in British Guiana, Jamaica, Trinidad, and Barbados, and the near future should show good trade in these quarters, and possibly also in other islands.

Jamaica.—In Jamaica the country is of a mountainous character, but many of the roads are quite good and are excellently maintained. Internal-combustion engined vehicles appear to be most suitable, as kerosene is obtainable anywhere, but coal is comparatively scarce. For general purposes, vehicles of about two tons would meet requirements, as these would not be too heavy for the roads. Sufficient power would be required to negotiate severe gradients, but excessive power would be undesirable if the vehicles are to be handled by native drivers, unless the maximum speed is very definitely limited. Natives who will train into good drivers should be obtainable for about 4*s*. per day. On many roads there are rivers to be forded, but if these are impassable it is generally possible to complete the journey by a detour, as the rivers are bridged. In Kingston there should be a good opening for vans carrying about one ton, for the use of tradesmen generally, and cold storage vehicles should be useful in several trades.

Trinidad.—There are a certain number of British-built lorries and vans in service in Trinidad, and results up to the present have been satisfactory. There are good openings for omnibuses, lorries, and private vehicles. Petrol is obtainable at 1*s*. 7*d*. per gallon, paraffin at 1*s*. 3*d*., coal at 30*s*. per ton, and wood at 10*s*. per cord. There is a sufficient general supply of water for steam vehicles. Roads are macadamised and of good surface. Gradients are only moderate, nothing much worse than one in ten being met. Ground clearance should be high, and solid rubber tyres of large section should be fitted. Native labour is available at prices varying from £1 to 75*s*. per week, but trained drivers are not obtainable on the spot. There are in all between fifty and sixty mechanically-propelled vehicles in the island.

British Guiana.—In British Guiana the roads are good, but there are some short sharp gradients and numerous abrupt turns over bridges. Generally speaking, the country is flat. There are no rivers to be forded, and the rates obtainable for the carriage of goods from the plantations are quite high enough to allow a margin of profit if motor vehicles are used. The quality of the water along the roadside is not very suitable for steam vehicles, but suitable water is available at sufficient intervals, and coal is also obtainable.

Bermuda.—An interesting example of the possibilities of road transport is to be found in Bermuda, but the name of this colony has not been mentioned as a likely field for motor traction, owing to the existence of prohibitive legislation against motor cars. At the moment of writing it is not certain how the rapidly-increasing tourist traffic in the colony will be dealt with, as rival proposals involving the use of either electric trams or motor vehicles have recently been under consideration. It is quite possible that a long monopoly may be granted to a tramway company, in which case the prohibition against road motors will probably continue in operation.

AUSTRALASIA.

There is a certain similarity in the demand for mechanical transport throughout Australia and New Zealand, though the latter is in general far more hilly. In the large cities, requirements do not of course differ very much from those of Great Britain itself, with the exception that a very adequate water-circulation system is necessary, owing to the climate, and that vehicles running out on to country roads require a high clearance. In all the big cities there is an increasing demand for taxicabs, and these are to be found in considerable numbers. For example, in July last there were forty-three motor cabs licensed in Sydney, and notice of registration of a further twenty-five had been given. The great majority of these cabs are of British make. The principal towns are taking up motor fire appliances and municipal motors very readily, and with good results. In many country districts there is a big demand for a suitable type of agricultural motor, and, generally speaking, for a tractor capable of negotiating unmade roads. There is also a big field for motor mail services in very many districts.

Naturally the principal towns form the chief centres from which the employment of motor

transport is likely to spread. Consequently, the following notes refer to the conditions in districts around some of the most important centres.

New South Wales: Sydney.—Motor vehicles are already extensively employed in Sydney for business purposes. The most popular type of vehicle at present appears to be the light petrol waggon for delivery purposes, designed to carry from 15 cwt. to two tons. The passenger-carrying vehicle is, comparatively speaking, a negligible quantity. Motor vans and lorries are already used in almost every conceivable trade. It is stated, however, that Sydney is behind Melbourne in the development of the new method of transport. If this be so, the topographical conditions may have something to do with the facts, Melbourne being built on flat land undivided by any expanse of water incapable of being bridged, whereas Sydney is replete with hills and inlets. Many streets are narrow and rough of surface. They are paved with hard wood blocks except on the most severe gradients. The most popular fuel is petrol, which costs about 1*s.* 4*d.* per gallon wholesale. Steam lorries have been used to some extent, but appear to be giving place to internal-combustion vehicles. Water is generally of poor quality.

Special requirements are not remarkable. Adequate clearance is, of course, necessary, and the same applies to the steering lock. Tyres should be of wide section. Bodies of all vehicles are generally built locally. Chain-driven vehicles should have their chains encased on account of sandy roads. Carburetters built for use in Great Britain are frequently incapable of taking as much air as is required in some districts in Australia. A reliable correspondent lays great stress on this point as deserving of the attention of makers. As regards drivers, labour is available in ample quantities, at 30 to 50 per cent. above English rates. Repairs are at present expensive. There are good openings for reliable driver-mechanics.

Queensland: Brisbane.—Mechanical transport has not yet developed as far in Brisbane as in Sydney, but, generally speaking, requirements are fairly similar, and during the last eighteen months cars have been imported at an increasing rate, and these appear to give general satisfaction. Only recently, the first "penny section" motor omnibus service to run in Australia was started in Brisbane by Mr. C. A. Wood. On the whole, motor omnibuses have not found favour to the same extent as goods-carrying vehicles.

Victoria: Melbourne.—The most popular type of motor vehicle in Melbourne at present is the 15 to 25 cwt. van or lorry for quick suburban delivery of goods. The large warehouses have been the principal buyers, and a certain number of two-ton and three-ton vehicles have also been put into service. Unless an enactment has been passed within the last month or so, Melbourne has as yet no licensed taxicabs, vehicles of this type being hired by arrangement from the garages. Generally speaking, there is a fairly good opening in Victoria for industrial motors, though horses are cheap, and it is consequently difficult to introduce a new method of transport. There are a certain number of motor tractors in use in agricultural districts, but this development has not yet expanded fully.

All fuels for petrol or steam vehicles are available. Petrol costs about 1*s.* 4½*d.* per gallon wholesale, kerosene about 10½*d.*, and coal about 24*s.* per ton. The use of steam vehicles is, however, restricted, owing to the scarcity of water in some parts of the country. The roads are chiefly macadam, but are rough and uneven on the surface, and there is generally a good deal of loose metal lying about. Gradients are not severe. As regards design, the usual colonial requirements hold good. At present it is somewhat difficult to obtain locally replacements of some of the best makes of rubber tyres. Labour is scarce and dear, and drivers have to be trained. The labour market is not at present in a satisfactory condition, but there are a fair number of concerns capable of dealing adequately with repair work.

South Australia: Adelaide.—Motor traction is not yet extensively employed in South Australia, but motor lorries of from one to five tons' capacity are just beginning to find favour. There are now about twenty in and around Adelaide, in the service of carrying companies, market gardeners, and merchants. About five lorries are fitted with seating accommodation and are used for picnic parties and passenger traffic. The Electric Light Company uses a six-ton petrol lorry for carrying coal. Reports generally are very favourable, and there is likelihood of a good deal of business being done in the near future. Most of the lorries in use have as yet been run less than twelve months. A Renard road train and a twenty-ton traction engine are in use in adjacent mining districts.

There is undoubtedly a big future for the motor tractor and motor lorry, as the country is very extensive and is not well served by railways. Agricultural motors are not yet used to any great extent, but a good machine of this type, easily manipulated and capable of ploughing about thirty acres a day, would find a ready market. The immediate demand will be, however, principally for lorries of from one to five tons.

Petrol costs about 1*s.* 4½*d.* per gallon. Paraffin is not at present used as fuel for motor vehicles in the district. Water is scarce in many parts, and steam vehicles are handicapped accordingly. Macadamised roads are, as a rule, only of moderate quality. Adelaide itself is on a plain with very few gradients. To the south and east there are hills with gradients of one in eight or nine, and occasionally one in five. In South Australia generally there are all sorts and

conditions of roads, many unmade, and situated in sandy and hilly country.

The principal local requirement is ample ground clearance, which should not be less than twelve inches in order to escape stumps, stones, and boulders. The wheel gauge should preferably be the same as that of farmers' waggons, say, from sixty to seventy inches. A good steering lock is an advantage in some cases. Rubber tyres are best for city use, and on the macadamised roads, but for agricultural or country work steel tyres with cross-bars should be fitted. Springs and axles should be strong. The bodies of the vehicles are nearly all made locally.

The average Australian, being very intellectual and resourceful, readily masters details of mechanism and makes a good driver. There are some well-equipped shops where repairs can be effected equal to the best British work, but at a higher cost owing to the rate of wages and cost of raw materials. A first-class motor mechanic will get 11*s*. a day of eight hours.

Any firm wishing to get hold of the trade in this district should send out a really good man to study the requirements on the spot.

Western Australia: Perth.—The roads for a radius of about twenty-five to thirty miles around Perth are suitable for fairly heavy motor work, the principal route being to Fremantle and to Midland Junction. There is here an opening for a parcels delivery service. Roads are somewhat sandy, but gradients are not severe. Between Fremantle and Perth there is a good route for a parcel and heavy goods service. The cartage of goods from Fremantle either by rail or by barge to Perth is accompanied by a good deal of tedious and annoying formality, and goods are not infrequently damaged on the way. Five-ton petrol lorries could operate the service for the heavier goods. A low fourth-speed may be useful for emergencies, and the water-circulating system should be thoroughly effective. For parcels delivery two-tonners would be suitable. Coal is dear, and water is scarce in places; consequently steam vehicles are at a great disadvantage. There is an opening for a passenger service between Perth and Guildford, a distance of about seven miles. There should also be room for a few motor chars-à-bancs for pleasure trips from Perth, especially to Mundaring Weir. Business houses in Perth could advantageously adopt vans carrying one to two tons. Early experiments in motor traction failed owing to incompetent management or faulty selection of vehicles.

Solid rubber tyres must be detachable without a press, road clearance must be ample, and large diameter road wheels would be an advantage. With the features mentioned, and with a very low fourth speed, the requirements of most reasonable districts in Western Australia should be well met. There is also an opening for a good agricultural petrol motor with the right type of wheel for sandy country.

New Zealand: North Island.—In Auckland there is an opening for a certain number of trade vans and also for a few cabs. A motor omnibus service has been tried, but was not well operated and was discontinued. It seems, however, as if there might be an opening in this direction. In the immediate neighbourhood there is not a very large field for agricultural or general-purpose tractors, but in the Waikato district there is stated to be a potential demand for an enormous number of engines of this type. These should preferably be fitted with internal-combustion engines, as petrol and paraffin are obtained at moderate rates, but coal and wood are both expensive, and water, though found in considerable quantities, is not always convenient to the roads. The road surface in the town is fair, but outside poor. The gradients, on the other hand, are heavy in Auckland itself, but very moderate in the country round about. In this district, as in the others mentioned above, special requirements are not exceptional. Moderately high engine power is needed, together with a reasonable ground clearance.

As regards labour, there is plenty of raw material available for drivers. Rates are, however, high, being from £2 15*s*. to £3 per week, with an eight-hour day. There is a scarcity of mechanics properly qualified by training to deal with the repairs of motor vehicles.

Going further south, Wellington is not very dissimilar in requirements from Auckland. Motor cabs are likely to be extensively used, and there is an opening for light vans for delivery work in the immediate vicinity of the town. Tram services work wherever the streets allow them to be safely operated, so there is probably no opening for motor omnibuses. The nature of the country round about is such as to restrict the use of the heavier type of lorry and tractor. The roads outside the town are bad; those inside are of good quality, but very frequently heavy gradients are found. The streets being in many places narrow, a sharp steering lock is advisable, and some form of non-skid tyre is to be recommended on the clay roads in the district, which get very greasy at times.

New Zealand: South Island.—Christchurch probably offers as good a field for the development of mechanical transport as any town or district in New Zealand. There is a good opening for vans, lorries, and cabs, and also for motor omnibuses feeding the tram systems and operating in less thickly populated districts. There will also be a big demand for agricultural motors and general-purpose tractors. These should preferably be fitted with internal-combustion engines, since, though all fuels are available at reasonable prices, water has to be obtained from artesian wells, and the supply cannot be depended upon in the country districts. The roads all about are

of good quality, and gradients are negligible. Conditions of labour are similar to those at Auckland.

In Dunedin there are again limited openings for vans and cabs. There is a very big field for agricultural tractors in Southland and along the east coast of the South Island. Either steam or petrol engines can be conveniently employed, as the cost of fuel is reasonable, and there is a sufficiency of water. The roads about Dunedin are of good quality, but newly formed, and consequently rather soft and heavy.

There are a few steam vehicles in use. Coke and good coal are obtainable at about 25*s*. a ton, and lignite at 9*s*. to 15*s*. a ton.

Powerful engines and wide tyres are desirable, and high clearance is essential. Weights should not be excessive. A complete set of spare parts should accompany every vehicle sent out. Pumps should be made with a good margin, as consumption of coal and water is high.

[NOTE.—For the information contained in the Appendix the writer is indebted to the following, and to a large number of other correspondents, who have taken considerable pains to give him the benefit of their intimate knowledge of local conditions :—

Mr. L. M. Dave, B.A., Managing Director of the Gujarat Automobile Transport Co., Bombay; Mr. J. H. M. Robson, Federated Malay States.

Messrs. Smith Bros. & Co., Users and Agents of Motor Vehicles, Port of Spain, Trinidad, B.W.I.; Messrs. MacDonald & Co., Concessionaires for "Albion" Cars, 80, Queen Street, Ottawa, Ontario; Messrs. Walter Hayes & Co., Vancouver, British Columbia.

Mr. Richard Ruben, Importer, Johannesburg; Mr. C. E. S. King, Cartage Superintendent, South African Railways.

Mr. G. Hamilton Grapes, A.I.A.E., Consulting Engineer, 160, Lambton Quay, Wellington, New Zealand; Mr. G. Canton, formerly of New Zealand; Mr. T. D. Chapman, Agent, Kenneth-street, Longueville, N.S.W.; Mr. Herbert Filmer, Editor of "The Motor in Australia," Sydney, N.S.W.; The Tarrant Motor Co., Melbourne, Victoria; Messrs. Duncan & Fraser, Motor Agents, 46, Franklin-street, Adelaide, South Australia; Mr. A. Adams, Perth Motor House, Hay-street, Perth, Western Australia.]

DISCUSSION.

The CHAIRMAN, in opening the discussion, said the audience had listened to a most interesting and comprehensive paper. It touched on a great many subjects; it foreshadowed what might take place in the motor trade, and he thought that the author was not very far wrong in his prognostications. In bygone days, when the railways were first being made, it was prophesied that they would be failures, because the wealthier classes would keep to the road in the old stage coach, but those prognostications were absolutely wrong. Now, the roads were being used again, and motors were carrying a very considerable number of passengers, as well as goods, which were previously carried by the railways. He did not think the motor trade on the road had in any way reached a climax; on the contrary it would very considerably increase. In the colonies the motor trade at the present moment was in its infancy, but before long he thought there would be a great increase there, and that our motor manufacturing trade in this country would depend very largely upon the number of motors that were sent to the colonies. He himself made his first road motor in the year 1869, since when he had devoted very considerable attention to the manufacture of steam tramway engines. He ran a very large number of these at the mileage rate, and made money out of them. He then came face to face with the heavy repairs which were necessary in those steam tramway engines. It might be interesting if he mentioned that where only a small number of tramway engines — a small fleet, as the author had expressed it—was possible in a town, it was very seldom that that fleet of tramway or motor engines could be worked at a remunerative rate, because first of all it was necessary to have a really competent manager, without whom it was impossible to have the repairs properly done. A competent manager required a competent salary, and a competent salary could not be paid unless the company owned a considerable number of motors, which in their turn required first-class people to do the repairs, because from the moment the motors started repairs became necessary. The motto, "A stitch in time saves nine," applied with particular force to motors. The motor required to be run a very large number of miles per day in order to work it remuneratively. His tramway engines each ran 100 miles a day, and he was never satisfied unless they accomplished that distance. He made it the practice to have a temporary overhaul one day a week, and a thorough overhaul one day a month. In that way the repairs were kept reasonably low, and the cost of running only amounted to sixpence a mile, running for ten years. That was only done by keeping the tramway engines in good condition. He was borne out in his contention by the success which the large London motor companies had achieved. They had competent managers, competent workmen, and, above all, every part was in duplicate. The author had referred to the question of Government subsidies in connection with motor vehicles, and he quite agreed with Mr. Wyatt in regard to that matter. Turning to the question of motor cabs, these could only be run by large companies at a profit; small companies could not run them at a profit, as they could not pay the expenses of the necessary high-class staff to keep the cars in repair. That was the reason why the large companies had prospered. With regard to sending out motors to the colonies, in order to be

successful they should be sent out in large batches, unless there were a very considerable number of motors already in the centres to which they were being sent, so as to be able to maintain the necessary repairing staff. If a garage was opened in those centres, then a competent staff could be maintained, and the motors could then be worked successfully. He did not think that without such a system of garages the scheme of sending out motors to the colonies would be successful, but when such a scheme did come into force, he thought the author's suggestions would be eminently practicable.

Mr. HOWARD D'EGVILLE said that he had devoted very considerable study and attention to the defensive aspects of Imperial questions, and it was only in that connection that he ventured to offer some comments on the paper. He had been very much interested in the remarks which the author had made with reference to co-operation betweeen the dominions and the United Kingdom in relation to the supply of motor vehicles for military purposes. In regard to the question of subsidising motor vehicles, he took it Mr. Wyatt referred to the necessity of Dominion Governments undertaking those subsidies, because, as was quite well known, the great over-sea dominions were now attaining independent positions, and, in any question of co-operation for mutual defence, the War Office at home could not be expected to undertake subsidies in regard to the self-governing dominions, although of course it would undertake them in connection with colonies in East and West Africa, and other parts of the world. He quite agreed with the author when he said that the extent of the motor industry in this country was not at present adequately grasped by the over-sea dominions, and he cordially supported the suggestion of demonstrating to colonial visitors at the Coronation the true facts of the case. In that connection he thought the Festival of Empire would afford a splendid opportunity of showing to the colonies the great possibilities of the motor industry in this country, and would also be a guide as to what was possible to be done at the great Imperial Exhibition which was to be held in 1915. Referring to the appendix, he saw the author mentioned Ottawa as a typical Canadian town for the motor industry. He did not agree with that; he thought there would be better opportunities in towns of greater population. There were, in fact, tremendous possibilities in the west of Canada, and also in the maritime provinces which were not referred to. Mr. Wyatt, however, had made a most useful and suggestive contribution to the study of the question in which he himself was most interested—that of Imperial military organisation.

Sir PIETER STEWART-BAM said the author had touched on a question which could not be but familiar to everybody who had anything to do with the colonies, namely, that better attention should be paid to orders which were sent from the colonies to the Mother Country. He also thought that manufacturers in this country should advertise their wares more extensively. With regard to what was being done by motor power in the colonies, only a few months ago he saw his friend Mr. Dean, the Minister of Agriculture in Natal, at Cape Town on his way to England with the object of buying additional agricultural traction engines for use in Natal, as they had done such excellent work in that colony. That showed that even in agriculture motors were beginning to take a prominent part. And not only in agriculture, but in travelling. Motors were now in use all over South Africa, so much so that one wondered how people twenty or thirty years ago could have got over the country without them. He thought the author's suggestion as to making a subsidy in connection with motors, with a view to using them in time of war, was an excellent one. Just as horses had been useful in time of war so, he thought, motors would be. But, speaking generally, not only in the case of motors but of everything else, those in the colonies, as Britishers, had the feeling that they wanted to do as much trade with the Mother Country as they possibly could. In that connection, however, he thought the people of the Empire did not push themselves forward enough. He did not wish to touch on politics, yet he wished to point out that, despite the 10 per cent. preference on all British goods going into South Africa, the Americans and Germans got the business. He believed the British manufacturer did his best, but it ought to be better known what could be manufactured in the British colonies. That was why the Imperial Exhibition was going to be held in 1915, in order to show not only to colonials but to people in this country what could be manufactured and produced in this country. Exhibitions had been held for the last twenty years showing what foreign countries could accomplish, and it was high time that stock should be taken of what the Empire could do. But there was no need to wait till 1915; and he threw out the suggestion to Mr. Wyatt that he should get into communication with the Committee of the Festival of Empire to see whether the scheme he had put forward could not be carried out under their auspices.

Mr. W. WORBY BEAUMONT said the great difference between the author's valuable paper and most of those which had been read more or less on the subject in that room for some years was that, having now arrived at something approaching perfection with certain kinds of motor vehicles, manufacturers were now looking out for an extension of the trade in those vehicles, and the most interesting part of the paper was indicative of the directions that should be taken and of the methods to be avoided in obtaining that trade, and in obtaining the kinds of vehicles necessary in other countries. Manufacturers had come to the point where they wanted to extend the use of the

vehicles that had been made, rather than to create new types; and the author particularly referred to a type which, if suitable for much of the colonial use, would be, more or less, or perhaps wholly, suitable for military purposes. Agreeing with him to a very large extent on that point, he (Mr. Beaumont) was bound to say that the struggle to produce vehicles of the kind Mr. Wyatt was referring to, other than of the traction engine type, was a struggle which seemed perhaps to be inevitable for a time, but one which should be considered, and would, he thought, hereafter be considered only as a struggle to get over temporary difficulties, difficulties that at all events ought to be considered as temporary; for instance, improvement and extension of the roads. One of the great difficulties the author referred to with regard to the colonies was that of clearance, the distance between the lowest part of the machinery, etc., and the ground. Wherever the author referred to that, of course, he meant that a vehicle was wanted which should be capable of working satisfactorily where roads either were not, or were bad. Taking that as an indication of what had to be done, mostly in the future perhaps, the question arose: What kind of vehicles, tractors, or others could possibly be made at the present time which would satisfy colonial requirements? Most of those requirements could be satisfied at present with the type of lighter powerful traction engines which were being made by several firms in this country—by people who had had very great experience in the production and use of such engines. There were, however, certain regions, both at home and abroad, where the conditions were such that no one type of vehicle could possibly be equally useful or equally good in either different colonies or different parts of colonies. So it came to a selection of vehicles that would suit particular districts and particular kinds of work. Hence, although the author had referred to details, he had referred to those which would pertain, or which pertained, to different kinds; almost, if he might be allowed to say it, as though those details were all referring to one kind of vehicle. He would like the author to make it a little clearer that it was several types, at least, of vehicles that really were wanted, and, with reference to that, the proposed exhibition should be carried out so as not only to show the different types of the really useful, practical, and durable things that were made in this country, but to enable visitors to see that there were those different types, and that they could apportion them, as he might call it, to the different purposes and places that they had in mind. Some, however, of the types now being called for would become unnecessary, and would be replaced by others far more useful and profitable when the need for more and better roads was attended to. Referring to that part of the paper which dealt with the early failures and successes, the maintenance question — the examination and proper overhauling of the machine—was of the greatest importance. It mattered not how good the vehicles were, whether traction engines or tractors, steam or oil engines, or motor omnibuses, all must fail unless those who owned them recognised that the machines included in their structure parts which were of the most delicate construction, and parts which had to be attended to, not only when defects showed themselves, but before defects showed themselves. There must be proper workshops available, so that men capable of doing the work should be in sufficient comfort to do it properly, and to do not only that which was obvious, but that which had to be discovered. In saying that he was repeating what he had insisted upon in that very room in his series of Cantor Lectures in 1903, but he mentioned it again because even in this country, owners of vehicles costing hundreds of pounds allowed their motors to get into such a condition that the nine stitches became necessary where one would have been sufficient. If that sort of policy were allowed to continue, no perfection of construction or of material would be good enough to make an otherwise successful motor vehicle a profitable thing either in this country or in the colonies.

Mr. Dugald Clerk, F.R.S., said, as one who had been concerned with internal-combustion engines for some thirty years, it was a matter of no inconsiderable interest to him to find the internal-combustion motor applied to every variety of possible usefulness. So far as the heaviest of all traction was concerned, steam traction still held the first place, by means of the heavy traction engines which were famous all over the world as English engines, notwithstanding tariffs and everything else. He had great hopes, however, that even in the heaviest of traction work, the internal-combustion engine would take its place. At present the internal-combustion engine, especially in the form of a petrol motor, had been more applied to cases where the power was not so great as was required in those heavier engines, apparently because the petrol engine became, for very heavy power, somewhat expensive in its fuel. It was possible, however, to see a way to applying internal-combustion motors to those heavy traction purposes by the addition of a fuel which had not been mentioned by the author; it was quite possible to use in countries where there was no coal, wood charcoal and also anthracite, and it was possible to make a heavy traction motor with an internal-combustion engine requiring only coal or wood charcoal. There was as much experimental work going on in England as in any other part of the world in every possible line, whether in steam turbines or internal-combustion motors, and he hoped that, in the heavy traction movement, this country might keep as well to the front as she had succeeded in doing in the lighter traction movement. He wished to say one word in support of the British manufacturers. He did not believe people quite gave them the credit for the amount of advertising and the amount of searching that they undertook in order to get work in the colonies

The firms he was connected with had people all over the world, and they had no difficulty whatever in getting custom. Of course, some people asked for a special article, but in modern manufacture the great secret of success was standardisation and manufacture on a large scale. England need not fear entering all markets, protected or unprotected, because her manufacturers had paid great attention to cheapness of production and to the manufacture of goods of first-class quality.

Mr. WYATT, in reply, said the discussion had amplified and explained points which he had possibly slurred over, or had failed to make sufficiently clear, and for that reason he had listened to it with the greatest possible interest. The discussion, also, had given the audience an opportunity of listening to men who had had experience over an extent of country of which he himself could not claim to know even a small part. With regard to the particulars which he gave in the appendix, he had been dependent in almost every case on correspondents resident in those places, and that was the case with regard to Ottawa, which Mr. D'Egville mentioned. Several speakers had referred to the prime importance of full facilities of repair and maintenance, and there, he supposed, all were in absolute agreement. He thought that rather strengthened the case for his suggestion of subsidising vehicles which were in many respects suitable for colonial and also for military use. Those vehicles, in his view, would be of several types, and the preponderance of certain types would depend upon the district in which the fleet was being collected. If the subsidies were granted by the Governments of the dominions, the result would be that in each dominion the fleet would be of a kind most suitable for operating in that dominion, and at the same time would become valuable in response to similar subsidies offered in this country by the British War Office; there would be a combination of the various fleets available in the dominions, and a great percentage of it would be suitable for war in any part of the world. With regard to Mr. Dugald Clerk's remarks, he seemed to agree with him (the author) that the British manufacturer was not solely to blame. He did not say for a moment that he was not to a certain extent to blame, but, if he might say so, when it came to the point it would be found that where he was to blame was that when a customer came in and asked for something which he could not sell him, he did not sell the customer something else. It had been said that any salesman could sell a man what he wanted, but only a good salesman could sell him what he did not want, and he believed that was how the Americans got in front of Englishmen in a great many British possessions over seas. He was very much obliged to the speakers for supporting his suggestions. The first of these—the motor subsidies—was a matter which must be left on the knees of the gods; possibly something of the kind might materialise in the future. With regard to the second suggestion, he had got a more concrete, though a far smaller proposal. He had ascertained that a large proportion of the leading manufacturers in the industrial vehicle motor trade in this country would support some such proposal as that which he had attempted to outline. He thought the difficulty of inviting the co-operation of the promoters of the Festival of Empire would be that it would not be worth their while to go to the trouble of assisting in any way which would be of any great value, unless the Exhibition was a far more permanent thing than he himself proposed. They would not use their influence to bring really practical and valuable men down to see the vehicles. In that connection he was very fortunate indeed to have the advantage of the presence and the opinion of Sir Pieter Stewart-Bam. To ask him to take anything more than a passing interest in a matter of the sort under discussion was really like using a sledge hammer to crack a nut, but if Sir Pieter would do so, the success of the thing would be absolutely assured. With regard to the experiences detailed by the Chairman, there was one remark which he felt he might comment upon. The Chairman referred to the fact that motor cabs could be run by large companies, but rather implied momentarily that the small man or individual owner could not make his living out of it. He thought the Chairman meant that the small man, if he were isolated and had to depend upon himself for repairs and maintenance, could not make a living, but the remark might be misunderstood to mean that the individual owner in a big city such as London would not be able to make a living against the big company. He, the author, believed, as a matter of fact, that although the individual owner must pay for his repairs and maintenance more than the big companies paid for the repairs and maintenance of one vehicle, the personality of the man, if he used it properly, and his power of working up a connection, and his personal interest in his own business, would balance any disadvantages, and he would make a good living out of his cab as things stood at the present time.

On the motion of the Chairman, a vote of thank to the author was carried, and the meetin terminated.

THE INTRODUCTION OF PHOTOGRAPHIC TRANSPARENCIES AS LANTERN SLIDES.

By SIMON H. GAGE,

Emeritus Professor of Histology and Embryology, Cornell University.

It is hardly possible for the multitudes of the younger generation of professional and amateur photographers to comprehend that the entire development of photography, as a useful art, lies in the period between 1839 and the present; and that many men are now living whose activities include

this entire period, and who successively witnessed the rise of the daguerreotype (1839), the calotype (1841), the albumen picture on glass (1847), the collodion picture on glass (1851), and finally the gelatino-bromide dry plates of the present.

It is also difficult to appreciate, when viewing the successive scenes of the magic-lantern and of the moving-picture machine, that a very much greater number of men living at the present time have witnessed the entire development of the photographic processes necessary to make such an exhibition possible.

From the first the wonderful, almost magical art of photography fascinated a multitude of workers in all Western nations. Many of the processes and much of the apparatus were repeatedly and independently devised or invented by many individuals. It is natural therefore that, although a man may have lived during the entire development of the art, he would have exact knowledge about only those parts with which he has been personally connected. At least this was found to be the case in the effort to trace the origin of the now almost universally employed photographic transparencies for lantern slides in place of the hand-painted pictures first used in the magic-lantern by Walgenstein as early as 1665.

As finally worked out it was found that photographic lantern slides were introduced by at least two different parties working independently and entirely unknown to each other. One utilised the albumen process of Niepce de Saint-Victor, and the other the collodion process of Scott Archer.

I. *Magic-Lantern Slides by the Albumen Process*, 1850.—Two brothers, W. and F. Langenheim, daguerreotypists and owners of Fox Talbot's patents in America for negative and positive pictures on paper, were successful artists in Philadelphia. In 1850 the brothers issued a catalogue of photographic lantern slides made by the albumen dry plate process of Niepce de Saint-Victor in which the positives as well as the negatives were made on glass.

The first published account which I have found concerning these photographic lantern slides is by the physicist, Robert Hunt, in the *Art Journal* of London, Vol. III., N.S., April 1st, 1851, pp. 105, 107. Hunt says: "In the original French photographs on glass, the negatives only were received on that substance, the positive copies being received on paper . . . In the *Hyalotype* both the positive and the negative impressions are obtained on glass, and the result is as near an approach to perfection as we can imagine. The *Hyalotype* is the invention of Messrs. W. and F. Langenheim, of Philadelphia . . . the proprietors of Mr. Fox Talbot's American patent. These gentleman state of their process that . . . 'the distinguishing feature consists in the material on which the impressions are taken. We have substituted plate-glass for the paper in the negative and also in the positive, altering the process to suit the new material' " . . . Robert Hunt continues: "The most interesting application of this discovery is the construction of magic-lantern slides from nature by the camera obscura without the pencil or brush . . . We have now before us a series of these magic-lantern slides—the *Hyalotypes*—and we feel bound to declare that their delicacy and the perfection of the details cannot be overstated. In a view of Spring Garden Hall, Philadelphia . . . the delineation of the details is marvellous . . . A view of the United States Custom House in Philadelphia is in every respect equally perfect . . . In this picture, for the purpose of showing the facilities afforded by this process, a slight transparent tinting has been given to the trees, a neighbouring house, and the sky; and thus by the magic-lantern is produced a picture faithful in all its details, with the beauty of colours superadded . . . Already these photographic artists have published 126 views around Philadelphia, Washington, and New York, including Mount Vernon, and the Capitol at Washington."

Many of these photographic lantern slides were sent by the Langenheims to the first International Exposition—"Exhibition of the Works of Industry of all Nations," held in London in 1851. The official report of the jurors of this Exposition, p. 227, has this to say: "Langenheim (U.S. No. 62) . . . This artist also exhibits a series of subjects designated by him under the name of *Hyalotypes*, being delicate miniatures excellently adapted for magic-lanthorn subjects. The material would appear to be collodion, albumen, or some similar preparation forming a film on glass, capable of receiving the impression."

In the illustrated catalogue of the Exposition issued by th: London *Art Journal*, p. xii., this is said: "The *Hyalotypes*, or photographs on glass, both positive and negative (many of the pictures being coloured for magic-lantern slides), are pleasing applications of the [photographic] art."

The *Athenæum* for June 14th, 1851, pp. 631-2, in discussing "Photography in the Palace of Glass," says, concerning the matter in hand: "The *Hyalotypes*, or glass pictures, are of a remarkable character. They are but a modification of the process of Mr. Talbot and of M. Evrard as applied to glass; but the idea of copying Nature on this material—and having obtained a fixed picture of the shadowed image, of magnifying it by means of the magic-lantern, and thus producing a truthful representation of the original—is certainly due to the artist of Philadelphia. Many beautiful views of the Smithsonian Institution, of the Custom House in Philadelphia, and of churches in several cities of the United States, show the minuteness of detail which can be obtained by the use of the albumenised glass."

II. *Magic-Lantern Slides by the Collodion Process*, 1851-2.—Every new process in photography was especially welcomed and enthusiastically practised in America, hence almost immediately after the publication of the *collodion process* by Scott Archer in the *Chemist*, in 1851, the photographers of the United States were making use of it for the production of *ambrotype* portraits, and it soon became applied to the production of lantern

slides as follows: A young physician near Boston, Daniel H. Briggs, like so many of the New England physicians, wishing to aid in the education and improvement of the community in which he lived by giving public lectures, and having skill in drawing and painting, put this to use in making hand-painted lantern slides to illustrate the lectures he gave on anatomy and geology. Hearing of picture-making on glass by photography, it occurred to him to apply the method to making lantern slides. After receiving some hints from Whipple, of Boston, who was making *ambrotype* portraits, he succeeded in making lantern slides by photography of the subjects upon which he was lecturing. These he coloured to give them the natural appearance.

Dr. Briggs was so successful with his lantern slides that he taught his son the art. In 1872 they moved to Philadelphia. The son, Mr. C. W. Briggs, who still continues the lantern-slide business in Philadelphia, has kindly given the following: "The process of the Langenheims, I find upon comparison of dates with my father's first work, 1851-2, was entirely different. They coated the glass with albumen and used a dry plate in exposing, while my father used a wet collodion plate. Each party worked entirely unknown to the other." Finally, in 1875, the Langenheims sold out their entire business, including negatives, etc., to Mr. C. W. Briggs.

It is thus seen that photographic transparencies were applied as magic-lantern slides almost as soon as the albumen and collodion methods with glass plates were devised. Both methods lent themselves to the production of perfect slides, and the first makers applied colours, as had been done with hand-painted slides. In a word, photographic lantern slides were perfected in the very beginning.

It is interesting also that Dr. Briggs used his first slides for illustrating lectures upon anatomy and geology, that is, for instruction in these subjects which are so largely illustrated by lantern slides in lecture courses of the present day. The first slides of the Langenheims were of buildings and natural scenery, portraits, engravings, and of war scenes. In the very beginning, then, photographic lantern slides included the whole field of illustration.

NOTE.—The writer wishes to acknowledge the aid rendered in gaining the information given above. First to Mr. F. D. Langenheim, of Philadelphia, son of W. Langenheim, who gave many references and much information concerning his father and uncle. Fortunately the evidence of the work of the Langenheims is in print and accessible to everyone, as noted in the text above. Second, to Mr. C. W. Briggs, who gave me the information concerning the part played by his father, Dr. Daniel H. Briggs, in introducing lantern slides made by the collodion process. So far as known to me this information is now first printed. Third, it is with pleasure also that I acknowledge the numerous courtesies of the Secretary of the Royal Society of Arts, Sir Henry Trueman Wood, in making inquiries and forwarding information to me upon this subject.—S. H. G.

HOME INDUSTRIES.

Shipbuilding in 1910.—The most striking fact connected with the shipbuilding figures for 1910 is that while British shipbuilders increased their output of new tonnage, other countries show decreases. The shipbuilding output of the United Kingdom last year was prejudicially affected by the lock-out; but, notwithstanding this, the total of vessels built in the United Kingdom in 1910 was 1,163 against 1,097 in 1909, with a tonnage of 1,339,488, as against 1,181,528 in the previous year. On the other hand, the returns show that the foreign output of vessels in 1909 was 1,403, in 1910 it was only 1,236, with a tonnage of 1,094,569 in 1909, as against 1,012,170 only in 1910. Taking the 1910 figures, they show that the output of tonnage in the United Kingdom in 1910 exceeded by 327,318 tons the whole of the foreign output, and if the Colonial output is included in the British returns, the British superiority is still more marked. In 1910 the British increase in output was about 158,000 tons, while the foreign decrease amounted to 82,000. The decreases abroad are mostly in Germany, Holland, and France, the German output having decreased by about 60,000 tons, the Dutch by about 50,000 tons, and the French by about 12,500 tons. There was an increase in the tonnage output of the United States of about 70,000 tons, partly due to the launching of a battleship in New York dockyard, but principally to the building of more tonnage of cargo steamers on the Great Lakes. America ranks next in tonnage output to Great Britain, but not in ocean tonnage. It is a remarkable feature of American shipbuilding that it is almost entirely confined to vessels for lake and coasting services. In the seaboard yards there were hardly any vessels built of the tonnage of those turned out for the lakes. It must, however, be remembered that the figures quoted do not take into account any vessels of less than 100 tons gross. Also that while the warship tonnage launched in the United Kingdom was 8,415 tons displacement more than in 1909, the total for abroad in this respect registers a decrease of about 102,000 tons. It is also evident that the United Kingdom is year by year building less for other countries. The amount of such tonnage launched in 1910 was 223,463 tons, the lowest percentage of the total output since 1904. This remark does not apply to the British colonies, which remain our best customers for new ships. The sales in 1910 of United Kingdom vessels to colonial and foreign owners reached the record total of 513,618 tons.

Liverpool, the Shipping Industry, and Combines.—At the annual dinner of the Liverpool Shipping Staffs' Association, Mr. Thomas Royden dealt with the growth of Liverpool during the last two

centuries and the enterprise of Liverpool shipowners who took the lead in substituting steel for iron, and have been among the first to adopt every improvement devised by the engineer and naval architect, with the result that they have now the finest and fastest steamers in the world. In responding to the toast of "The Shipping Trade of Liverpool," Mr. R. D. Holt, M.P., made some observations upon recent absorptions which are well worth reproducing. He said he was not at all sure, as a Liverpool man, having the real interests of Liverpool at heart, that he liked to see the way the business of the port was being rolled up into gigantic concerns and combinations—some of them of a national and others of an international character. It was no good fighting against movements which had a solid economic foundation. If those combines did their work efficiently and economically it was not the slightest use kicking against them; they had to accept such conditions, but he confessed he did not like it. He did not like the tendency which deprived the town of a large number of independent persons, and there was no doubt it was a great misfortune. If they did not find an increase in the number of firms, independent people, and principals of firms, while at the same time the business of the port was increasing, it was really a misfortune to the town and district as a whole. He said that with some confidence, for he thought a great deal of the prosperity of Liverpool shipping, and the port of Liverpool had arisen from the fact—in the main—that the shipping had been controlled by Liverpool men born and bred in the town, living there most of their lives, and hoping to die there. He hoped when those combinations came about—if they had to come—that some of them would see that a fair portion of them were managed and controlled in the good old town.

Manchester and Australian Produce.—Mr. R. V. Billis, Mr. Hugh Mackenzie, and Dr. Elwood Mead recently visited England in order to find markets for Australian produce. They have now reported, and find that: (1) Other countries are doing their utmost to cater for the exact requirements of British buyers. (2) Under present conditions the Australian producer does not receive such good returns as he might. (3) One of the best markets in Great Britain is, so far, comparatively unexploited by Australia. Upon this last point the Report makes the following observations:—

"The undeveloped market is those densely populated counties Lancashire and Yorkshire, and indeed the whole of the west of England and Midlands and portions of Scotland, while the chief receiving and distributing centre for these parts should be Manchester. Undoubtedly a large portion of frozen meat, fresh fruit, and rabbits from Australia reaches Manchester and from there is distributed among the consumers of the west and north, but such produce comes *via* either London or Liverpool, and is subject to many handlings and to much unnecessary expense. The consuming population in the immediate vicinity of the Manchester Ship Canal is over 2,000,000. Within a radius of 75 miles, containing 177 important towns, there is a population of 12½ millions, and the Manchester docks are nearer to every one of these towns than any other port. Furthermore, it is the practice of buyers from more distant towns to visit the Manchester markets regularly, so that this city is in reality the mart or trading centre for an enormous population. Here is a community numbering quite twice the population of Australia and New Zealand, and it is a community possessing unusual purchasing capacity, still it cannot boast—or Australia cannot boast—a direct steamship service from Australia to it."

Railway Dividends.—The railway dividends already declared must be considered satisfactory. For the second half of 1910 the Great Eastern has declared a dividend at the rate of 4½ per cent., in comparison with 4 per cent. for the corresponding half of 1909, and with 3¾ per cent. for the second half of 1908. Great Eastern Stock may now be bought at about 70, which gives a yield of £4 12*s.* 3*d.* per cent. after allowing for accrued dividend. The Chatham dividend is also a good one, being at the full rate of 4½ per cent. on the first half year, with an increase of £32,700 in the carry forward, so that it is not unlikely that there will be a full 4½ per cent. for the year which ends on June 30th. An additional £41,000 received from the Joint Committee by the South-Eastern has enabled the resumption of dividends on South-Eastern Deferred. The Directors have announced a dividend at the rate of 6 per cent. per annum on the Undivided Ordinary in comparison with 5 per cent. a year ago. The dividend on the Undivided Ordinary for the whole of 1910 is 3½ per cent., which compares with 2¾ per cent. for 1909, and 2½ per cent. for both 1908 and 1907. The Central London Railway has done better. The dividend at the rate of 3 per cent. per annum on the Undivided Stock, giving 2 per cent. on the Deferred, is unchanged, but £8000 more is placed to reserve, and the balance carried forward shows a slight increase. The Metropolitan continues to show steady progress. Over 100,000,000 passengers used the line during the past year. In the past six months the gross receipts increased by £12,400, and a saving of £5,500 was effected in working expenses. The net profit has increased £20,800. A dividend at the rate of 1½ per cent. per annum is to be distributed as against only 1 per cent. for the corresponding period of 1909. The dividend for 1910 is 1⅜ per cent. against 1 per cent. in 1909, and ½ per cent. in 1908. The City and South London dividend is unchanged, namely at the rate of 1¼ per cent. per annum, but the balance carried forward has increased from £712 to £1788.

The British Silk Trade.—The expression of the

Queen's intention to use in her coronation robes silk made by British manufacturers has naturally given much satisfaction to the trade, and the Silk Association of Great Britain has just held a conference to consider the best means of increasing the trade in British silks. A good deal was said at this conference about the need for closer co-operation between the makers and the sellers. It is often said that it is difficult to get British silk, and that when obtained it is expensive and of inferior quality, but the truth of these statements is contested. It is not claimed that the British manufacturer can supply every kind of silk goods, but there is an increasing output of British silk which compares favourably in every way with foreign goods. What is wanted is the application of art and taste for design and colour to the technical processes of the trade. It was urged by more than one representative of the retail trade at the conference that the manufacturers should come direct to the retailer as foreigners do. Often the retailer does not know whether the goods brought to him are British or foreign. And the foreign maker seems to be more willing to study the requirements of the retailers. The merits of the spun silk in which the British firms excel should be more widely advertised. As it is, 90 per cent. of the silk supplied to the high-class dressmakers comes from France, Italy, and Switzerland. Patriotism is not sufficient to induce people to buy British silk. The manufacturers must pay greater attention to the wants of the public. The foreigner takes the greatest pains to find out where he is beaten in the English market, and to produce exactly what is wanted in finish and price. One of the difficulties of the business is that it depends on the varying demands of fashion, and the leaders of fashion go abroad for their ideas.

Tin.—At the end of 1909 tin was quoted at £153 per ton, at the end of last year it had risen to £174; it is now quoted at £190, and it may soon be up to £200 per ton. There was no substantial change in the visible supply of tin last year as compared with 1909 until December. At the end of November it was 20,500 tons, or much the same as a year earlier, but since then the visible supply has dropped to 17,910 tons, as compared with 21,385 tons a year ago, the shipments for December being much below the average, whilst those for December 1909 were unusually heavy. The probability is that prices will remain high and go somewhat higher than the present high quotation. Apart from market manipulations, there are two causes operating in favour of the producer. The tin plate industry, both in America and the United States, is remarkably active, and the falling off in the shipments from the Straits Settlements in 1910 was nearly 4,000 tons as compared with 1909 and 5,800 as compared with 1908, a shrinkage due to some extent to the scarcity of labour caused by the extension of rubber cultivation in Malaya. There is not much likelihood of other parts of the world supplying the deficiency.

OBITUARY.

Sir Francis Galton, D.C.L., Sc.D., F.R.S.—Sir Francis Galton died at Grayshott House, Haslemere, on the 17th inst., at the age of eighty-eight. A grandson of Erasmus Darwin and a cousin of Charles, it was natural and in accordance with his own theories that he should distinguish himself in a scientific career. Intending at first to enter the medical profession, he studied for a time at Birmingham General Hospital and at King's College, London, but in 1840 he proceeded to Trinity College, Cambridge, where, but for a breakdown in health, he would probably have gained a high place in the Mathematical Tripos. On leaving the University he spent several years in various parts of the then unknown Dark Continent, and in 1853 he published an account of his travels in the "Narrative of an Explorer in Tropical South Africa." For this work he received the Founder's Gold Medal of the Royal Geographical Society, and was elected a member of its Council.

Mr. Galton next turned his attention to the study of meteorology, and took a considerable part in devising the early weather charts which appeared in the *Times*. He also served as a member, and for some time as chairman, of the Managing Committee of Kew Observatory.

It was, however, in connection with anthropological science that his name is most widely known. In 1869 he published "Hereditary Genius: an Inquiry into its Laws and Consequences," in which his thesis was to show that genius is mainly a matter of ancestry. This was followed in 1874 by the appearance of "English Men of Science: their Nature and Nurture," which formed a statistical study of 180 men prominent in the English scientific world of that time, giving particulars of their ancestry, health, stature, size of head, etc., and in 1883 by "Inquiries into Human Faculty and its Development," in which he discussed the practicability of supplanting inefficient human stock by better strains, "thus exerting ourselves to further the ends of evolution more rapidly and with less distress than if events were left to their own course."

In 1895 Mr. Galton published his "Finger-Print Directories," and the system therein recommended for the purpose of identifying criminals has been adopted, with some modifications, by the Home Office.

Of late years most of Mr. Galton's attention was devoted to the problems of National Eugenics, defined by him as "the study of those agencies under social control that may improve or impair the racial qualities of future generations either physically or mentally." In 1904 he endowed a Research Fellowship in the University of London, and established a laboratory where an immense quantity of statistical information bearing on various lines of eugenic inquiry has been accumulated.

During the course of his long life Mr. Galton

received many honours in recognition of his scientific achievements. In 1855 he was elected a member of the Athenæum Club under Rule II. From 1857 to 1863 he was hon. secretary of the Royal Geographical Society; from 1863 to 1868 he acted as general secretary to the British Association; he was twice president of its Geographical Section and also of its Anthropological Section. In 1860 he was elected a Fellow of the Royal Society, which, in 1886, awarded him a Royal Medal in recognition of his statistical inquiries into biological phenomena, in 1902 the Darwin Medal, and in 1910 the Copley Medal. He also received the degree of D.C.L. from the University of Oxford in 1894, and that of Sc.D. from his own University in the following year, while in 1902 he was elected Honorary Fellow of Trinity College, Cambridge. In 1909 he received the honour of knighthood.

He joined the Royal Society of Arts in 1876, and read before it a paper on "Physical Tests in Competitive Examinations" in 1890. He also took the chair at several of the Ordinary Meetings.

Robert Forrester.—The death took place at Seattle, Washington, on the 19th December, of Mr. Robert Forrester, in his forty-seventh year. Born in Scotland, he graduated with honours from the University of Edinburgh, and shortly afterwards proceeded to America. In 1889, after studying the coal formations in the coal districts of Pennsylvania, he settled in Utah, of which territory he was appointed United States Coal Mining Inspector, and became well known throughout the States as one of the most reliable coal experts in the country. He also acted as Consulting Engineer to the Denver and Rio Grande and Western Pacific Railways. Mr. Forrester was a member of the Royal Geological Society of Edinburgh, the American Institute of Mining Engineers, and many other scientific bodies. He joined the Royal Society of Arts only last year.

Charles Letts.—Mr. Charles Letts, who died at the latter end of last year at the age of sixty-three, was a constant attendant at the meetings of the Society and took a lively interest in a variety of subjects. He was admitted as a solicitor in 1870, and was a member of the firm of Messrs. Letts Brothers. He possessed a large collection of London prints and other objects of literary and antiquarian interest, and was well informed on the history of the subjects to which he devoted his attention. He served on the Council of the London Topographical Society, and was a member of the Royal Institution, the Royal Society of Literature, and the Faraday Society. He joined the Royal Society of Arts in 1897.

Captain Thomas Bridges Heathorn, R.A.—The Society has lost an old member by the death of Captain Thomas Bridges Heathorn, which took place on the 23rd inst. at the age of eighty. He served through the Crimean War with the artillery of the Turkish contingent, and during the Indian Mutiny he commanded the mountain train at Kotah, and was afterward mentioned in despatches for the action at Chotah Oodeypore. In 1868 he served on the Committee of Armaments under the late Sir William Gordon. He was elected a member of the Society of Arts in 1862, and took part in the discussions on several occasions.

NOTES ON BOOKS.

Scientific Handicraft. London: J. J. Griffin and Sons, Ltd.

This bulky work of over a thousand pages, while professing to be a price list of the physical apparatus manufactured and sold by Messrs. Griffin, is really quite a useful textbook on the subject of such apparatus. The first edition of "Scientific Handicraft" was published in 1866, and was then a catalogue of the firm's chemical apparatus. The second edition, published in 1877, is in the library of the Society, and has constantly been used up to the present date as a very useful book of reference on the subject with which it specially deals. Later editions of their list of Chemical Apparatus have since been published by Messrs. Griffin, and the old book of 1877 is in many respects obsolete and out of date. But even now it contains a great deal of very valuable information, and is in frequent use. The present book, dealing only with physical apparatus, is more distinctly a catalogue than the earlier book, and it does not appear to contain the interesting notes with which the founder of the firm enriched his catalogue. But it nevertheless seems to be, like its predecessors, a very useful and convenient work.

The American Flag. Compiled and edited by Harlan Hoyt Horner. Albany: State of New York Education Department.

In this supplemental volume to the sixth annual report of the New York State Education Department, Mr. Horner gives a very complete and interesting account of the American flag. Its origin would appear to be wrapped in as much mystery as that of Mr. Yellowplush himself, for Mr. Horner dismisses as "pleasant tradition" the story of George Washington calling upon the young widow, Betsy Ross, at her upholstery shop in Philadelphia, and asking her if she could make a flag; and that thereupon they set to work together and devised a design of thirteen stripes and thirteen stars, which was the original form of the present banner. The flag's authentic history begins on June 14th, 1777, when the American Congress formally resolved: "That the flag of the thirteen United States be thirteen stripes, alternate red and white; that the Union be thirteen stars, white on a blue field, representing a new constellation." The flag appears

to have been first displayed on August 2nd at Fort Swanwix, which an American garrison was preparing to defend against the British forces. On that day the garrison was reinforced by a detachment of the Ninth Massachusetts Regiment, who brought news of the recently-enacted statute. It was determined, amid great enthusiasm, to make a flag at once. The fort was ransacked for the materials, which were finally found in a soldier's white shirt, a woman's red petticoat, and a piece of blue cloth from the cloak of a certain Captain Abraham Swartwout. This account is confirmed by a letter from the captain asking for cloth to replace that which was taken to make the flag. The steps by which the present design of the flag was evolved are carefully traced with the aid of numerous excellent illustrations. The book also includes a collection of songs celebrating the Stars and Stripes, which, if they do not always rise to the highest poetry, are never deficient in patriotic fire.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

February 1.—Philip Joseph Hartog, M.A., B.Sc., "Examinations and their bearing on National Efficiency." The Earl of Cromer, G.C.B., O.M., G.C.M.G., K.C.S.I., C.I.E., Vice-President of the Society, will preside.

February 8.—Captain A. J. N. Tremearne, B.A., D.Anth., "Some Nigerian Head-Hunters." Colonel Sir John Smith Young, C.V.O., will preside.

February 15.—George A. Stephen, "Modern Machine Book-binding." John Murray, J.P., D.L., F.S.A., will preside.

February 22.—Professor J. Wertheimer, B.Sc., B.A., "Water-Finders."

March 1.—Dr. Leonard Hill, F.R.S., "Caisson Sickness and Compressed Air."

March 8.—James Cantlie, M.A., M.B., C.M., D.P.H., "Plague and its Dissemination." Sir Shirley Forster Murphy, M.R.C.S., will preside.

Wednesday afternoon, at 4.30 o'clock:—

March 15.—Colonel Charles Edward Cassal, V.D., F.I.C., "The Adulteration of Food." The Right Hon. the Lord Mayor of London will preside.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

February 9.—R. A. Leslie Moore, I.C.S. (retd.), "Indian Superstitions." Lord Lamington, G.C.M.G., G.C.I.E., will preside.

March 16.—Claude Hamilton Archer Hill, I.C.S., C.S.I., C.I.E., "Education in India."

April 27.—Sir Thomas Henry Holland, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India." Lord Avebury, D.C.L., LL.D., F.R.S., will preside.

May 25.—W. R. H. Merk, I.C.S., C.S.I., LL.D., "The N.W.F. Province of India."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

January 31.—F. Douglas Osborne, M.Inst.M.M., "The Tin Resources of the Empire." Sir William Hood Treacher, K.C.M.G., will preside.

February 28.—The Hon. Sir Richard Solomon, K.C.B., K.C.M.G., K.C.V.O., K.C., M.A., High Commissioner for the Union of South Africa, "The Resources and Problems of the Union of South Africa."

April 4.—Captain R. Muirhead Collins, C.M.G., "Australia and her Resources."

May 9.—F. Williams Taylor, "Canadian Banking."

Cantor Lectures.

Monday Evenings, at 8 o'clock:—

Frederick Wedmore, "Etching." Two Lectures.

Syllabus.

Lecture II.—January 30.—"Modern Etching." Goya—Wilkie and Geddes—The Silence before the Revival—The great French Outburst—Méryon, Bracquemond and Jacquemart — Haden and Whistler—Themes mainly Landscape, Portraiture, Architecture—The Etching of To-day.

Professor Adrian J. Brown, M.Sc., "Brewing and Modern Science." Four Lectures.

Syllabus.

Lecture I. — February 6. — Introduction. Dr. Graham's Lectures Thirty-seven Years Ago—The Brewing Process a succession of Complex Biochemical Changes—Barley: Classification of types used by the Maltster—Barley from the Agriculturist's and Brewer's Points of View—Present Position of Knowledge regarding Characteristics of Malting Barley—Results of recent Experiments on Barley Cultivation in Ireland, etc.

Lecture II.—February 13. — "Malting." Constitution of the Barleycorn — Character of Changes during Germination—Investigations of the Biochemistry of Germination—The Barleycorn a highly-specialised seed, etc.

Lecture III.—February 20.—"The Mashing Process." The Chemistry of Starch and its Transformation Products—Protein Changes during the Mashing Process.

Lecture IV.—February 27.—"The Fermentation Process." Previous Treatment of the subject

by Dr. G. Salamon in 1888—The Pure Yeast Question in Brewing—Zymase and Modern Views of Alcoholic Fermentation—Nitrogen Assimilation—The so-called "secondary" products of Fermentation, etc.—Conclusion.

Professor J. A. FLEMING, M.A., D.Sc., F.R.S., "Applications of Electric Heating." Four Lectures.

March 6, 13, 20, 27.

ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

May 1, 8, 15, 22.

Dates to be hereafter announced:—

FRANK M. ANDREWS, "Architecture in America."

ARTHUR CHARLES DAVIS, F.C.S., Assoc.Inst.C.E., "The Manufacture and Testing of Portland Cement."

GEORGE B. HEMING, "Art Education in Jewellery and Goldsmithing."

Professor RAOUL PICTET, "Les Basses Températures."

Sir WILLIAM ABNEY, K.C.B., D.C.L., D.Sc., F.R.S., "The Quantitative Measurement of Colour-Blindness."

HAL WILLIAMS, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

NOEL HEATON, B.Sc., F.C.S., "The Production and Identification of Artificial Gems."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 30...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. F. Wedmore, "Etching." Lecture II. — "Modern Etching."

Geographical, Burlington-gardens, W., 8.30 p.m. Dr. H. A. Lorentz, "Recent Explorations in Dutch New Guinea."

British Architects, 9, Conduit-street, W., 8 p.m. President's Address to Students.

Actuaries, Staples Inn Hall, Holborn, W.C., 5 p.m. Mr. Henry William Manly, "Staff Pension Funds: The Progress of the Accumulation of the Funds; The Identity of a Valuation with the Future Progress of a Fund; The Manner of dealing with Funds which are Insolvent; and Sundry Observations."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. R. W. A. Brewer, "The Art of Aviation."

Engineers, Junior Institution of, Caxton Hall, Westminster, S.W., 7.30 p.m. Mr. L. W. G. Costello, "The Law Relating to Engineering." (Lecture VI.)

East India Association, Caxton Hall, Westminster, S.W., 5 p.m. Miss Hilda M. Howsin, "Race and Colour Prejudice."

TUESDAY, JANUARY 31...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Mr. F. Douglas Osborne, "The Tin Resources of the Empire."

Illuminating Engineers, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Discussion on "Library Lighting."

Royal Institution, Albemarle-street, W., 3 p.m. Professor F. W. Mott, "Heredity." (Lecture III.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Papers by—1. Mr. C. W. King, "Sand-Movements at Newcastle Entrance, N.S.W." 2. Mr. C. S. R. Palmer, "Fremantle Harbour-Works, Western Australia." 3. Mr. Gerald H. Halligan, "The Bar Harbours of New South Wales."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. T. G. Newmarsh, "Through Algeria to the Sahara."

WEDNESDAY, FEBRUARY 1...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m Mr. P. J. Hartog, "Examinations and their Bearing on National Efficiency."

Public Analysts, Chemical Society's Rooms, Burlington House, W., 8 p.m. 1. Annual General Meeting. 2. Dr. Philip Schidrowitz and Mr. H. A. Goldsbrough, "Note on the Detection and Estimation of Small Quantities of Antimony." 3. Messrs. G. E. Scott-Smith and John Evans, "The Analytical and Microscopical Examination of Compound Liquorice Powder." 4. Mr. Clarence A. Seyler, "Commercial Analysis and Arithmetic."

Builders, Koh-i-Noor House, Kingsway, W.C., 4 p.m. Professor Beresford Pite, "The Teaching of Building Construction and Architecture."

Royal Archæological, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. J. W. Willis Bund, "Ancient Bridges and their Impending Destruction."

THURSDAY, FEBRUARY 2...Women's Aerial League, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 3 p.m.

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Linnean, Burlington House, W., 8 p.m.

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. H. B. Baker and G. H. J. Adlam, "The Constancy of Water of Crystallisation in Hydrated Salts. Part I." 2. Messrs. H. Davies and F. S. Kipping, "Different Methods of Applying the Grignard Reagent." 3. Mr. A. H. Salway, "The Orientation of the Nitro Group in Nitromyristicinic Acid." 4. Mr. F. G. P. Remfry, "The Condensation of Aromatic Aldehydes with Nitromethane." 5. Messrs. A. Holt and J. E. Myers, "The Phosphoric Acids." 6. Mr. W. J. Jones, "The Determination of Solubility Coefficients by Aspiration." 7. Messrs. M. O. Forster and F. M. van Gelderen, "The Triazo Group. Part XVI. Interaction of Nitrosates and Sodium Azide."

London Chamber of Commerce, Savoy Hotel, Strand, W.C., 7.30 p.m. Dinner and Discussion on British East Africa, to be opened by Sir Percy Girouard.

London Institution, Finsbury-circus, E.C., 6 p.m. Professor Silvanus P. Thompson, "The Life and Work of Lord Kelvin."

Royal Institution, Albemarle-street, W., 3 p.m. The Astronomer-Royal, "Recent Progress in Astronomy." (Lecture III.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Rev. D. G. Cowan, "The Land of the Vikings, including the Island of Bornholme."

Roentgen Society, 19, Hanover-square, W., 8.15 p.m.

FRIDAY, FEBRUARY 3...Royal Institution, Albemarle-street, W., 9 p.m. Mr. A. E. Shipley, "Grouse Disease."

Civil Engineers, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. W. Henry Hunter, "Rivers and Estuaries." (Vernon-Harcourt Lecture.)

Geologists' Association, University College, Gower-street, W.C., 7.30 p.m. President's Address on "Flint and Chert."

SATURDAY, FEBRUARY 4...Royal Institution, Albemarle-street, W., 3 p.m. Mr. A. Hassall, "Problems in the Career of the Great Napoleon." (Lecture III.)

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FRIDAY, FEBRUARY 3, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

PUBLICATION OF THE "JOURNAL."

In consequence of the threatened strike in the printing trade, it has this week been found necessary to go to press at a much earlier date than usual, and therefore it has been impossible to include in this number a complete report of the discussion on Wednesday's paper. The portion omitted will appear in the next issue.

NEXT WEEK.

MONDAY, FEBRUARY 6th, 8 p.m. (Cantor Lecture.) Professor ADRIAN J. BROWN, M.Sc., "Brewing and Modern Science." (Lecture I.)

WEDNESDAY, FEBRUARY 8th, 8 p.m. (Ordinary Meeting.) Captain A. J. N. TREMEARNE, B.A., D.Anth., "Some Nigerian Head-Hunters." Colonel Sir JOHN SMITH YOUNG, C.V.O., will preside.

THURSDAY, FEBRUARY 9th, 4.30 p.m. (Indian Section.) R. A. LESLIE MOORE, I.C.S. (retd.), "Indian Superstitions." Lord LAMINGTON, G.C.M.G., G.C.I.E., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday Evening, the 30th inst., Mr. FREDERICK WEDMORE delivered the second and final lecture of his course on "Etching."

On the motion of the Chairman, Mr. ALAN S. COLE, C.B., a vote of thanks was accorded to Mr. WEDMORE for his course.

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

Tuesday afternoon, January 31st, Sir WILLIAM HOOD TREACHER, K.C.M.G., in the chair. A paper on "The Tin Resources of the Empire" was read by Mr. F. DOUGLAS OSBORNE, M.Inst.M.M.

The paper and discussion will be published in a subsequent number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A Meeting of the Indian Section was held on Thursday, January 19th, 1910, Sir FELIX SCHUSTER, Bart., presiding.

The paper read was—

BANKING IN INDIA.

By REGINALD MURRAY.

In dealing with this ponderous though important subject I will first describe the conditions of trade finance in India before joint-stock banking became a prominent factor, and, as my own experience goes back sufficiently far for the purpose of such description, I will confine myself to facts which are within my own personal knowledge.

I will, then, refer to the various incidents which have contributed, during the last fifty years, to set back India's credit in the City of London, and why I consider that India as a field for investment offers much securer and more varied opportunities for investment of sterling capital than has been recognised hitherto by London capitalists.

Until the English system of banking was introduced in the interior as well as at the coast-ports of India, trade was financed chiefly by a class known as "banias," hailing for the most part from the Province of Marwar, who combined trading with money-lending and finance. In addition to these there were the Chetties of southern India, who were more money-lenders than traders, and the Bhattias and Parsis of Bombay and Guzerat, who were almost exclusively traders. It has also to be borne in mind

that nearly every native of India, more especially perhaps in Bengal, is a money-lender at high rates of interest to needy neighbours whenever he has more cash in hand than he requires for his own immediate wants. Money-lenders on a large scale are called Sahucars and Mahajans. All such money-lending continues, but the finance for the transport of merchandise from one part of the country to another is now passing more and more into the hands of the joint-stock banks, and the money-lenders themselves are making use of these banks for deposit and remittance. Where there are still no banks, as in the agricultural districts, the old money-bag system still prevails, a system which may be termed plutocratic. For by it the possession of money is individualised and distributed slowly within contracted circles, while the joint-stock banking system is democratic, collecting and distributing impartially from and to a large portion of the whole of India. Under the old system, if high rates of interest or some fancied form of security were not available, the money-lender would sit tight on his money-bags. At times he would be advised by his Jogi or Sunyasi, or holy ascetic, that it was an unpropitious time to invest. Some persons, especially large zemindars, believed it added to their importance and popularity to display huge piles of money-bags on rent days and festive occasions. One way and another, before the introduction of the joint-stock banking system, the total amount of currency lying idle must have often exceeded Rs. 50 crores, or five hundred million rupees (£33,000,000).

For holding or hoarding purposes coin and bullion were preferred, and it can therefore be easily understood how much time and trouble it took to count and weigh them when they were being taken in to the hoard, and how slow and laborious was the task of restoring them to circulation; consequently, how extremely inelastic was the finance of trade, and how the system encouraged—and still encourages, where it is continued—organised bands of dacoits or armed robbers.

With regard to set-backs of confidence which have done so much to discourage London capitalists from embarking in Indian enterprise, I would refer you to the serious collapse of India's credit produced in 1866 by the extraneous influence of the cessation of the American Civil War. I might have first mentioned the Indian Mutiny of 1857, but that was before my time, and the set-back was not so important, as trade at that time had not been opened up to large proportions by the construction of the Suez Canal, and the extension of Indian railways.

Still, notwithstanding the evidence of India's subsequent prosperity, it is apparent that either distance or the more attractive gilding of mining ventures elsewhere, or Chilian nitrates or rubber, or humanitarian exaggeration, have in some way contributed towards raising the mirage of another mutiny on the Indian horizon.

Though the temporary collapse of trade in 1866 caused a set-back, the previous few years of unexampled though adventitious prosperity had opened the eyes of all concerned to the potentialities of India. The Indians of the Western Province were quick to grasp the situation, and the great strides which have since been made in trade and industry in the Bombay Presidency have been largely due to the praiseworthy enterprise and business capacity of the Jewish, Bhattia and Parsi communities of Bombay and Guzerat. Indian enterprise in the Northern Provinces has also been very marked of late years; but the larger industries of wool, cotton and leather manufactures in the North, of jute and cotton manufacture in Bengal, of tea cultivation in Assam, Darjeeling, and, together with coffee in Southern India, of oil and coal-mining in Bengal and Burma, of gold-mining in Mysore, and the large fleets of coasting and river steamers were all initiated and are still for the most part supported by British money and control.

The next set-back to India's credit in London was the instability of the exchange between India and England. Up to the year 1870 exchange seldom fell below 1*s*. 10*d*. per rupee, the par being 2*s*. Thereafter, commencing with the demonetisation of silver in Germany, the price of silver began to fall. By 1876 the gold value of the rupee had fallen to 1*s*. 6*d*., in 1886 to 1*s*. 4*d*., in 1890 to 1*s*. 2*d*., and in 1893, about the time the mints were closed or a few months later, transactions were reported in the neighbourhood of 1*s*. 0¾*d*. During these years the United States made strenuous efforts to resist the fall of the metal which was so seriously affecting their own country, but the steps taken of buying up large quantities of silver had only the effect of disclosing supplies more than equal to the demand, and greater collapse ensued as soon as their buying ceased. The wide and violent fluctuation in the sterling rate of the rupee affected trade in India, by making it more subservient to exchange than responsive to supply and demand; it restrained sterling capital from flowing to India owing to the

prospect of redemption at a loss; and it made the fiscal policy of the Indian Government the sport of the elements. The remedy of closing the mints, and subsequent legislation upholding the value of the rupee at 1*s.* 4*d.*, has been completely successful, and owes its organisation in a large measure to the able and masterly advocacy of an Indian banker, the late Mr. A. M. Lindsay, of the Bank of Bengal.

The complete success of the reformed system of Indian currency was triumphantly proved during the crisis of 1907–8, and there is no longer any reason why fear of instability should deter the flow of sterling capital to India.

The third set-back was the Boer War. Why it should have been so is unexplainable, but there is the fact that while money was poured like water on to dust-heaps in Rhodesia, not only was Indian enterprise neglected, but it was, and I believe still is, a common instruction from investors to London brokers to avoid even Indian Government sterling securities for private investment, notwithstanding the comparative steadiness of rupee-loan paper in India.

This comparative steadiness is remarkable because the rupee loans issued in India since 1896 have been subscribed to almost entirely by Indian investors, and must have totalled over Rs. 20 crores, and in addition, according to the returns of the Public Debt Office in Calcutta, the holdings of rupee paper in London, which were represented as over Rs. 26 crores in 1896, now stand as under Rs. 14 crores, and the holdings of Indian investors have thus been further increased by Rs. 12 to 13 crores.

Now, when every cause of alarm engendered by previous circumstances should have been allayed, India is again set back by a catch-phrase derived from the headlines of newspapers, "Unrest in India." As a flare to distort the countenances of political adversaries such a phrase may be termed applicable, but if it is applied to the condition of India, and more especially to Indian trade and financial stability, there is no more tune in it than in a watchman's whistle.

It is sometimes said that the acts of violence and seditious propaganda of a few ill-balanced Indians are the result of western education. But what I am more sure of from my own experience of forty years in the East, spent mostly in India, is that western education and association with western people have taught them much better than they had realised before "what pays," and have taught them to appreciate a better style of living and freer opportunities of enjoyment. They have no ambition to go back to the days when famine was unrelieved, and when bands of freebooting sepoys spread over the land, looting as they went. The Indians are not fools. They are realising that however old and good a form of civilisation may have been it cannot stand still; that the world, linked up as it is now by rapid means of communication, cannot exist in sections; that they must join the universal throng or perish in solitude; that saintliness and respect for custom are excellent qualities when opposed to immorality and uncleanliness, but when opposed to honest and intelligent aspirations they exceed their mission. In aspiring to a larger share of government they are courting a democracy which could not endure amid the ancient forms of intense conservatism, and in the evolution towards more liberal and, I may add, less selfish and cramped ideals, the progress of banking is having a powerful and practical educative influence. As Mr. John Bright said in one of his famous speeches: "Is custom to be venerated because it is old, or ought we not rather to affirm with Cyprian that custom without truth is agedness of error?"

These, Mr. Chairman and gentlemen, are the preliminaries which I have desired to place before you, and which, after demonstrating the progress of banking, I may advert to briefly again at the end of this paper as claiming for India a fair meed of confidence and credit, and for the banks a share in having had a corrective and stimulating influence for the general weal.

Dealing now with the progress of banking, I will review shortly the history of the introduction of English banking into India.

Until 1809 there were no chartered or joint-stock banks on modern lines in India. The mercantile houses acted as private bankers for Europeans, and the Indian shroffs conducted the trade finance. Indians universally kept each his own money in his own house. The first chartered bank was the Bank of Bengal, which received its charter from the East India Company in 1809. The Governor-General at that time was Lord Minto, the distinguished grandfather of the Viceroy who has just retired, to enjoy, we may hope, many years of leisure and the well-merited thanks of his countrymen after five years of arduous and successful work under unusually difficult and almost exasperating circumstances. The fact that at least twelve new Indian banks were incorporated under the Act, and that there was such an extensive development of trade and finance, as I will presently show you,

during those five years is evidence of the confidence reposed in Lord Minto's administration, as is also the fact that the so-called "unrest in India" had no more effect upon local credit than it had upon his patience and unbiassed discretion.

The first Bank of Bombay was established under a similar charter in 1840, and the Bank of Madras in 1843. Under the early charters the Government was a shareholder to the extent of about one-tenth of the capital. The banks were authorised to issue notes against a proportion of Government securities lodged with the Accountant-General, and the Government exercised the right to nominate three officials on the board of directors. The circulation of notes up to 1862 appears never to have exceeded Rs. 2 crores in Bengal, Rs. 1½ crores in Bombay, and Rs. 20 lacs in Madras. In 1862 the privilege of issue was withdrawn from the banks, and the note circulation from and after that year has been issued solely and exclusively by the Government. At first the banks, now known as the Presidency Banks, were employed as the departments of issue and payment of the Government currency notes; but in 1867, after the commercial crisis, the Government set up a separate currency office where the entire control of the note circulation and of the reserves held against the same is separately administered. The total active note circulation, according to recently-published statements, is about Rs. 53 crores as against Rs. 13 crores in 1890, and Rs. 9 crores in 1870. The reserve held by the currency office at the present time is Rs. 41 crores in coin and bullion, Rs. 10 crores in Indian Government securities, and the equivalent of Rs. 2 crores in English Government securities.

Statements of the circulation and the reserves held are published weekly, and it is difficult to conceive a more perfect, more public, and more automatic system, one which bears constant evidence of redemption at call, and which contracts and expands exactly according to the requirements of the community, no more and no less.

About the same time—that is, in 1867—the Government ceased to be a shareholder, and in lieu of privileges withdrawn the new charters contained an undertaking on the part of the Government to keep with the Presidency Banks a minimum balance in cash from the civil treasuries, and to assign to the banks as a Government Department the management of the Public Debt. In consideration of this support the Government retained, and still retains, the right to nominate three members of the board of directors.

Of the banks with sterling and dollar capital and head offices in London and China, there are now existing only four of those which were existing in 1870 and earlier, and only one now existing was added up to the end of 1909, since which one more has commenced business. My progressive statement, presently to be shown, contains the figures of the first five banks only, and as regards deposits those in India only. Capitals and reserves are totalled in sterling and dollars, but, beyond showing a measure of prosperity, cannot be taken as money employed solely in India, as all the banks have branches in other countries. The deposits in India correctly or approximately show, so far as these banks are concerned, the growing popularity of banks as places of deposits in substitution for vaults and holes in the ground and other hiding-places. These banks have now thirty-two branches in India.

Forty years ago there was only one Continental or foreign bank represented by branch establishments in British India, now there are five. I have not included these in my progressive statements, as, although they do employ a considerable amount of capital in the Indian trade, it is improbable that they have many rupee deposits.

The Presidency banks had forty-six branches in 1870, thirty-eight in 1890, and fifty-three in 1910. The banks incorporated in India other than the Presidency banks have, with few exceptions, been established during the last twenty years. There were two with two branches in 1870, five with sixteen branches in 1890, and thirty-five with 220 branches in 1910. Of the last-named, sixteen had capitals of Rs. 5 lacs and upwards, with 161 branches, and nineteen had capitals of less than Rs. 5 lacs, with fifty-nine branches. I will now refer you to Appendix I.

The figures of this appendix are of banks now existing; nearly all have been kindly supplied to me by the banks themselves, and the others come from the India Office library, and should, therefore, be approximately correct. Numerous small banks may have been omitted, but none, I believe, whose figures would materially alter the result. Also it must be brought to notice that a few banks and banking concerns which held considerable deposits failed or closed between 1870 and 1890, and between 1890 and 1910. The actual increase in deposits between 1870 and 1890 was probably less than is shown in the appendix, as there was considerable

distrust occasioned by the continual fall in exchange during that period, and probably most of the deposits recovered from failed banks which are not included in the total of 1870 were remitted to England. Since 1890, and especially since 1900, I think it may be assumed that the deposits of banks which have closed business have, for the most part, been transferred to other banks, but even if we were to take deposits in 1890 as Rs. 1 crore more on account of banks which have closed, and whose figures are not shown in this appendix, it would still leave a colossal proportion of increase in 1910.

I have included in my Appendix I., Table B, foreign trade, and Table C, railways and canals, in order to show the concurrent progress in trade, in the means of communication, and in the aid to agriculture. The coasting trade, of which I have not given the figures, has increased from about Rs. 12 crores to about Rs. 50 crores during the period under review.

About thirteen years ago, and always before that time, the circulation of money in the chief cities of export did not keep pace with the advance of trade, industry and railway extension. At the end of 1897 the rate of interest in the Presidency towns jumped from 5 to 9 per cent. within a month, rose to 12 per cent. in February, 1898, and did not fall below 7 per cent. till July. The rains of 1896 had failed and caused famine in 1897, and consequently the warehouses in the Presidency towns overflowed, necessitating large advances from banks and others. There was not sufficient money in the Presidency towns to finance the produce which arrived after the succeeding good autumn harvests, and this insufficiency of money did not arise because money was not in the country, but because there was no machinery for moving it when wanted from the interior to the Presidency towns. In this connection, and as explaining the meaning I wish to convey in the figures of the appendix before you, I take the liberty to quote an extract from an article which I contributed to *Capital*, the leading financial paper of Calcutta, in 1900 or 1901.

"What we want is a gauge to the financial capabilities of India, both for the successful enterprise of trade, industry and agriculture, and for the true economy of Government administration. I have no hesitation in asserting that no truer gauge can be obtained than by the extension of the joint-stock banking system.

"Railways and canals . . . have gone ahead . . . steamers are increasing annually in size and speed . . . Progress has been very marked in the extension of tea and jute cultivation, and in all kinds of agricultural produce. Manufacturing industries have sprung up in all parts of India, and coal-mining has advanced with rapid strides.

"The only motive power which has not kept pace with the general progress of the country is the most important and, up to the present time, the most neglected. I refer to the machinery for attracting, economising, and distributing credit and money.

"That this factor has been neglected is apparent in the dearth of working capital. Hardly is there an industrial concern in India which is not frequently hampered by want of working capital. Hardly ever does a busy export season occur without finding the Presidency towns bare of loanable funds. The coasting and internal trade is chronically brought to a standstill from want of discounting facilities, and even municipal, port trust, and Government loan securities are occasionally unmarketable.

"All this has been recognised for some time past, and has seemed to point to a deficiency of capital in a poor country. The Government of India conceived that the best way of introducing capital would be a State bank with large capital. Obviously, however, the first thing to do is to exploit the capital within the country before resorting to the more expensive and less efficient method of borrowing from abroad. The best-known method of exploiting capital is by the extension of the joint-stock banking system, because it is only by this system that capital can be automatically concentrated and distributed. That the joint-stock banking system extends over a very contracted area in India is evident from the small aggregate amount of deposits held by the banks . . . This is not, as is often supposed, due wholly, or even chiefly, to the hoarding habits of the native population, but it is largely due to the fact that there are not bank offices, branches or agencies situated within convenient reach of would-be depositors."

This extract shows what heavy calls there were upon India, progressing in everything but financial facilities, and how the extension of banking was the obvious remedy.

The appendix proves the correctness of the diagnosis by showing that the remedy has been adopted with extraordinary readiness in all three Presidencies, and markedly in the Punjab. I remember receiving in 1903 a letter from a Punjabi, whom I did not know, saying that, after reading my pamphlet (one then published), he was determined to keep no money in his house

in future, but to open a deposit account. I think he may have been moved by what appeared upon the last page of the pamphlet, which I will exhibit to you. (*See* Appendix IV.)

The total increase of deposits during the last twenty years has been not less than Rs. 50 crores, and in addition the capital and reserves of local banks have increased over Rs. 6½ crores. The inference may be drawn that a considerable part of this large sum of money thus put into circulation has come from hoards, or money privately stored, and I consider that this inference stands good even after allowing for the larger volume of sterling money now lying temporarily in India attracted by the effective working of the Currency Reform Act of 1893.

The effect of the increase of banking capital and deposits in the interior has been the necessity to look to the Presidency cities for investment, and consequently nearly all of these up-country banks have opened branches or agencies in the Presidency towns to employ a portion of their resources. In this way money which would remain idle for some months if left in the interior has been remitted to the Presidency towns, and has replenished the supply of money there, so that, notwithstanding the last two seasons of good harvests and large exports, the Government has not been called upon to coin any fresh rupees for over two years, and money in the Presidency towns has been at no time under strain. You cannot fail to realise what a great advance this is—finance cheapened and money flowing to the points of greatest pressure; also money making money which formerly ran to waste through unemployment.

This great progress is to my mind important, not only in regard to what has been accomplished, but also as to what may still be accomplished, and although I will not guarantee to live another twenty years in order to prove it, I will venture on another diagnosis.

I foresee that the banking progress, great and rapid as it has been, is only a commencement. The volume of deposits will increase in those towns where banks have already been established, and will certainly be stimulated if some of the smaller banks amalgamate with each other or with larger ones. You will see by the map which will now be shown to you, that there is plenty of room for further extension. The towns at which banks are established are underlined in red. When you consider that the eleven leading joint-stock banks in London alone have 2,588 bank offices and £474,000,000 in current and fixed deposit accounts, and allow for the larger population and smaller individual wealth in India, as being, for the sake of comparison, a set-off one against the other, the only conclusion can be that banking in India, though showing signs of vigorous growth, is still in its swaddling clothes.

The Marwari or Bania class, to whom I have already alluded, is one to which India is greatly indebted, more indeed than to any other class, for financing the agriculturists, and in moving produce from the growing to the consuming districts and distributing goods of all kinds all over the continent from our most northern frontiers to Cape Comorin. Banks are not in any way a hindrance to their trade; on the contrary, they must greatly assist them. The banks relieve them of much trouble and risk. Carrying about and secreting bags of rupees are no longer necessary when banks are handy. At present there are almost no banks in agricultural districts, but when they are established in the market towns of those districts, as they are certain to be sooner or later, both Marwaris and many others will find it convenient to make deposits and employ the banks for remittance. The general circulation will be very largely increased and facilitated when these districts are linked up with a system which will then become universal.

What may and should attract banks to agricultural districts is the growing popularity of co-operative credit societies. By advancing to these societies a fair interest would be obtained, and, as argued below, it should be an advantage to the Government to assure such advances against loss. I am entitled to speak about co-operative credit societies, because I had the honour to serve on the committee which framed the Bill, and I am therefore fully cognisant of the objects and reasons and all that these societies were hoped to effect. It was naturally some years before they could be explained and understood in more than a few districts. The stout, but by no means obstinate conservatism of the agriculturist had to be satisfied that the innovation was for his benefit. He had to gain confidence in his own powers to administer his own village finance; to rely upon himself and not upon the money-lender. The latest reports indicate that the system has now, so to speak, "caught on," and, if so, it is likely to spread all over the continent of India. Everything will depend upon the funds forthcoming to give these societies a start, and in this I think joint-stock banks may find it profitable to take some share. I believe that some advances have been

made by the Government, and others by syndicates of zemindars and wealthy tenants who are interested in the good cultivation of their lands. But such advances will cover a comparatively small number of societies, and if, as appears probable, further aid will be necessary, an inducement to joint-stock banks to come in would be offered if the Government could guarantee the advances. This should not be difficult, as every society is organised and afterwards conducted under Government supervision. Considering that in the aggregate considerable advances have, as I understand, been made direct by Government to these societies, and in the form of private loans to individual agriculturists called "taccavi," no greater risk would be run by giving a guarantee to banks. Provincial expenditure would thereby be economised. The banks, by being encouraged to establish themselves in agricultural districts, would cheapen the finance for collecting and transporting produce and for importing necessities and luxuries, besides having, as elsewhere, an educative and stimulating influence.

My remarks have now portrayed the past and sketched the possible future progress of banking in India. Before concluding, I think I may usefully state what my experience and observation suggest as steps needful to be taken to safeguard this progress from the perils to which a too hasty advance is liable to give birth. A common caution, which, though not always practised, is probably more respected in commercial than in political circles, is "look before you leap." In commerce and banking, Credit, with a capital C, is the great regulator. It has been said that Credit lives at No. 1 the World. If it is abused the abuser suffers. It is a solid, unchangeable and impartial standard of commercial soundness and thoroughness, and is impervious to the attacks of malcontents and the ignorance of popular clamour. Its veto cannot be disputed.

Reverting to my suggestions, I think it may be desirable that the Government of India should consider the advisability of refusing to register banks with less than a minimum of paid-up capital. Some proportion should be fixed between the amount of capital (including reserves) and the amount of deposits. Deposits stand in relation to the public in much the same position as bank or Government currency notes, for which an adequate reserve is universally enforced. It would be very undesirable that the Government of India should enforce safeguards by means of an inquisitorial department, but there is no reason why an Act controlling joint-stock banks should not be passed. The Indian Companies Act of 1882, under which banks are classed promiscuously with other joint-stock companies, is, in many instances, unsuitable for modern banks. The nature of a bank's business is, in some respects, the antithesis of that of other joint stock companies. The business of the former is to lend, of the latter to borrow; the one to grant and protect credit, the others to exploit it. One Act cannot be worded to conform to both classes of companies, and, moreover, banks, as I have pointed out, need some special safeguarding clauses.

In this connection another Act is required in India. The Indian Companies Act stipulates that all companies' balance-sheets shall be certified by auditors, but no definition is given of the duties, responsibilities, and qualification of auditors. If banks are to be safeguarded by Act of Government for the protection of creditors and shareholders, the Government must either appoint its own inspectors to see that the Act is conformed to or must pass such an Act as will make professional auditors responsible, and clearly define their duties and responsibilities and the limit of their powers. Such auditors and no others should be qualified to certify banks' and other companies' balance-sheets.

One more word about credit. Credit in England is a real living force, a standard around which no fuss is made, but none the less respected as the safest vehicle of finance. I am under the impression that Indians have the same respect for, and appreciation of, credit, and may be relied upon to conduct banking with discretion and with a strict regard for integrity. I add these remarks because we have so often seen a rise of banking contain unpleasant history. In some countries credit is extolled and set up like a marble statue, a thing of beauty without life. It is in such countries only that banking enterprise is dangerous. Credit may be said to be the religion of trade. It protects, but cannot be protected except by observance of its principles.

ADDENDA.

Since writing this paper I see from the Indian papers that the Upper India Chamber of Commerce have made some valuable suggestions for amending the Indian Companies Act of 1882, and recommend, in the interest of all concerned, some amendments in the Act to define more clearly the limit and sphere of action of companies registered as "banks." They refer to forty-seven new banks having been registered

in 1908–9, with paid-up capitals aggregating a little over Rs. 3,00,000, whereas I include in my list only three banks established in those years with a total paid-up capital of slightly over Rs. 1,50,000. If, therefore, there have been forty-seven new banks opened, it means that forty-four of them have a total paid-up capital of a little over Rs. 1,50,000, or less than Rs. 4,000 each, and it would appear, therefore, that the registration of banks is subject to no limits as regards capital.

In turning to Appendix II., "Statistics of British India for 1908–9," I find only sixteen local domiciled banks included, and of these two were defunct. It is explained that all banks whose aggregate of capital and reserve are less than Rs. 5,00,000 are excluded, and also the numerous small native money-lending and pawnbroking establishments which are registered annually as "banks" under the Indian Companies Act.

You will see from my list that the nineteen banks included as having capitals and reserves of less than Rs. 5,00,000, have deposits of Rs. 1,75,00,000 = £1,166,666, which, I think, is too large a sum to be neglected. I suggest also that the registering of small money-lending and pawnbroking establishments as "banks" is a somewhat promiscuous exercise of authority.

These additional notes and remarks add force to the suggestions already put forward that some legislation is desirable to check the abuse of, and serve as a regulator for, a system which has an extensive influence for the good in every country in which the true principles of credit guide its operation.

APPENDIX I.

TABLE A—BANKS.

	1870.	1890.	1910.
Presidency Banks—			
Capital	Rs. 3,36,25,000	3,50,00,000	3,60,00,000
Reserves	,, 25,57,000	1,02,74,000	3,17,50,000
Deposits (excluding Government balances)	,, 8,58,62,000	9,24,23,000	33,82,34,000
Increase in Deposits	—	7½%	294%
Five Exchange Banks—			
Capital	£2,351,000	2,353,000	2,899,000
	$3,500,000	7,500,000	15,000,000
Reserves	£191,000	670,000	2,690,000
	$700,000	4,400,000	29,500,060
Deposits	Rs. 2,82,21,000	7,11,76,000	20,07,32,000
Increase in Deposits	—	152%	611%
Sixteen Local Banks—			
Capital Rs. 5 lacs and upwards	,, 9,50,000	28,50,000	2,64,16,000
Reserves	,, 1,15,000	11,42,000	95,37,000
Deposits	,, 17,61,000	2,15,88,000	19,22,89,000
Nineteen Local Banks—			
Capital less than Rs. 5 lacs	,, —	—	26,01,000
Reserves	,, —	—	6,41,000
Deposits	,, —	—	1,74,98,000
Total Deposits, Local Banks	,, 17,61,000	2,15,88,000	20,97,87,000
Increase	—	1,126%	11,770%
Total Deposits, deducting from Presidency Banks one-third, as representing the Deposits of other Banks	,, 8,92,23,000	15,43,79,000	63,60,09,000
Increase		73%	613%

APPENDIX I.—*continued.*

Table B—Foreign Trade.

	1869-70.	1889-90.	1909-10.
Exports—			
Merchandise	Rs. 54,89,10,000	1,03,46,04,000	1,87,72,00,000
Treasure	„ 1,72,14,000	1,90,63,000	6,39,90,000
Total	„ 56,61,24,000	1,05,36,67,000	1,94,11,90,000
Increase	—	86%	244%
Imports—			
Merchandise	Rs. 33,17,39,000	69,19,75,000	1,17,05,00,000
Treasure	„ 11,61,89,000	17,45,95,000	37,42,00,000
Total	„ 44,79,28,000	86,65,70,000	1,54,47,00,000
Increase	—	93%	245%

Table C—Railways and Canals.

	1869-70.	1889-90.	1908-09.
Railways—			
Mileage	4,771	16,104	30,983
Increase	—	237%	547%
Canals—			
Acres irrigated	—	9,171,211	16,425,527
Increase	—	—	79%

APPENDIX II.

Distribution of Banks by Provinces (excluding Foreign Banks).

In	9	towns of	Bengal provinces	28 Bank offices
„	4	„	Ebassam „	5 „
„	39	„	Punjab „	98 „
„	5	„	Frontier „	10 „
„	1	„	Rajputana „	3 „
„	1	„	Beloochistan provinces	8 „
„	1	„	Central India „	2 „
„	29	„	United „	85 „
„	2	„	Central „	6 „
„	2	„	Berar „	2 „
„	3	„	Bombay „	17 „
„	4	„	Guzerat „	10 „
„	8	„	Sind „	21 „
„	16	„	Madras „	23 „
„	5	„	Burma „	12 „
„	11	„	Native States „	16 „
In	140	towns	throughout India	341 „

The towns having the most Bank offices (excluding Foreign Banks) are the following—

Lahore	20 Bank Offices	including	6 Head Offices
Calcutta	18 „	„	4 „
Bombay	13 „	„	4 „
Delhi	11 „	„	2 „
Amritsa	9 „	„	1 „
Karachi	9 „	„	0 „
Lucknow	9 „	„	1 „
Cawnpore	8 „	„	0 „
Rangoon	8 „	„	2 „
Madras	6 „	„	2 „

APPENDIX II.—*continued.*

List of Banks Referred to in this Paper.

Presidency Banks.

Name of Bank.	Date Established.	No. of Branches. 1870.	1890.	1910.
Bank of Bengal	1809	20	16	23
Bank of Bombay	1868	10	7	13
Bank of Madras	1843	16	15	17*
				53
				-1
				52

* Including one in Ceylon.

Exchange Banks with Head Offices in London and China—

Name of Bank.	Date Established.	No. of Branches in India in 1910.
Chartered Bank of India, Australia and China	1853	6
Delhi and London Bank, Ltd.	1844	4
Hongkong and Shanghai Banking Corporation	1866	3
Mercantile Bank of India, Ltd.	1893	6
National Bank of India, Ltd.	1863	13
		32

Local Banks registered under the Indian Companies Act having Capitals and Reserves of more than Rs. 5 lacs—

Name of Bank.	Date Established.	Head Office.	No. of Branches.
Allahabad Bank, Ltd.	1865	Allahabad	17
Alliance Bank of Simla, Ltd.	1874	Simla	8
Bank of Burma, Ltd.	1904	Rangoon	3
Bank of India, Ltd.	1906	Bombay	0
Bank of Rangoon, Ltd.	1905	Rangoon	1
Bank of Upper India, Ltd.	1862	Meerut	11
Bengal National Bank, Ltd.	1907	Calcutta	0
Bombay Merchants' Bank, Ltd.	1907	Bombay	5
Indian Bank, Ltd.	1906	Madras	0
Indian Specie Bank, Ltd.	1906	Bombay	16
Kaycohta Trading and Banking Corporation	1899	Gorakhpur	7
Oudh Commercial Bank, Ltd.	1882	Fyzabad	2
People's Bank of India, Ltd.	1900	Lahore	54
Punjab Co-operative Bank, Ltd.	1905	Amritsar	8
Punjab Banking Co., Ltd.	1890	Lahore	13
Punjab National Bank, Ltd.	1895	Lahore	16
16 Banks			161

Local Banks registered under the Indian Companies Act having Capitals and Reserves less than Rs. 5 lacs—

Name of Bank.	Date Established.	Head Office.	No. of Branches.
Allahabad Banking and Trading Co., Ltd.	1891	Allahabad	0
Ajodhia Bank, Ltd.	1894	Fyzabad	0
Amritsar Bank, Ltd.	1904	Lahore	10
Benares Bank, Ltd.	1904	Benares	1
Bhargara Commercial Bank, Ltd.	1892	Jubbulpore	1
Bank of Multan, Ltd.	1907	Multan	3
Bhowanipore Banking Co., Ltd.	1896	Calcutta	0
Co-operative Hindustan Bank, Ltd.	1908	Calcutta	0
Deccan Bank, Ltd.	1901	Poona	0
Doaba Bank, Ltd.	1908	Amritsar	6
Gorakhpur Bank, Ltd.	1895	Gorakhpur	2
Hindustan Bank, Ltd.	1904	Multan	19
Kashmiri Bank, Ltd.	1882	Fyzabad	0

APPENDIX II.—*continued.*

Local Banks registered under the Indian Companies Act having Capitals and Reserves less than Rs. 5 lacs (*continued*)—

	Date Established.	Head Office.	No. of Branches.
Lahore Bank, Ltd.	1906	Lahore	3
Marwar Bank, Ltd.	1906	Hissar	5
National Bank of Upper India, Ltd.	1908	Lucknow	0
Orient Bank of India, Ltd.	1907	Lahore	4
Punjab and Sind Bank, Ltd.	1908	Amritsar	2
Union Bank of India, Ltd.	1898	Delhi	3
19 Banks			59

Foreign Banks having Branches in India—

Deutsch-Asiatisch Bank	Bombay and Calcutta
Comptoir National D'Escompte de Paris	Bombay
International Banking Corporation of New York	Bombay and Calcutta
Netherlands Bank	Rangoon
Yokohama Specie Bank	Bombay

APPENDIX III.

List of Towns supplied with Banks.

Abbotabad.
Agra.
Ahmedabad.
Ajmere.
Akola.
Akyab.
Allahabad.
Alleppy.
Ambala.
Amraoti.
Amritsar.
Arrah.
Azamgarh.
Bahawalpur.
Bangalore.
Bannu.
Bareilly.
Baroda.
Bassein.
Basti.
Batala.
Benares.
Bharnagar.
Bhera.
Bimlipatam.
Bombay.
Broach.
Calcutta.
Calicut.
Campbellpur.
Cawnpore.
Chakwal.
Chandausi.
Chittagong.
Chupra.
Cochin.
Coconada.
Dacca.
Dalhousie.
Darjeeling.
Dehra Dun.
Delhi.
Dera Ghazi Khan.
Dera Ismael Khan.
Ferozepur.
Fyzabad.
Gaya.
Ghazipur.
Gonda.
Gorakhpur.
Gujranwala.
Gurdaspur.
Gurgaon.
Guzerat.
Gwalior.
Hafizabad.
Hathras.
Hissar.
Hoshiarpur.
Hyderabad (Deccan).
Hyderabad (Sind).
Indore.
Jabalpur.
Jaijon.
Jalgaon.
Jalpaiguri.
Jammu.
Jaunpur.
Jhang.
Jhansi.
Jhelum.
Jodhpur.
Jullundur.
Kapurtala.
Karachi.
Karnal.
Kasur.
Kohat.
Kolhapur.
Lahore.
Larkana.
Lucknow.
Ludhiana.
Lyallpur.
Madras.
Mandalay.
Mangalore.
Masulipatam.
Mattra.
Meerut.
Mianwali.
Montgomery.
Moradabad.
Moulmein.
Mozuffatgarh.
Mozuffernagar.
Mozufferpur.
Multan.
Murree.
Mussoori.
Nagpur.
Naini Tal.
Naoshera.
Narainganj.
Nasik.
Negapatam.
Ootacamund.
Patiala.
Patna.
Peshawar.
Phagwara.
Poona.
Quetta.
Rajanpur.
Rajkor.
Rangoon.
Rawal Pindi.
Saharanpur.
Sakkar.
Sarodha.
Secunderabad.
Serajganj.
Shikarpur.
Sholapur.
Shujabad.
Sialkot.
Simla.
Sirsa.
Sitapur.
Srinagar.
Surat.
Tanjore.
Tank.
Taran Tarn.
Tellicherry.
Tuticorin.
Ujjain.
Vizagapatam
Wazirabad.

APPENDIX IV.

Reasons why Everyone Should Deposit their Savings in Banks.

1. If money is kept in a private house it attracts thieves. If thieves come to take money they may take lives as well.

2. If money is kept in a house or in a hole in the ground, the possessor earns no interest. On all money deposited with banks a depositor receives interest which is paid half-yearly.

3. Money deposited in banks is more readily available, and gives the owner less trouble than money kept in a house or buried; because if he wants to make a payment, instead of opening boxes and counting coins and notes, he writes a cheque and the bank takes all the trouble for him. Similarly, if a depositor receives payment by a cheque, instead of going a journey and collecting the money himself, he sends the cheque to his banker, who saves him the trouble without charge.

4. Keeping money on deposit with a bank costs nothing, but, on the contrary, yields a bi-annual return. Money kept in a house or buried costs much time and trouble, and if strong rooms or vaults are built, or iron safes purchased, the expense is considerable.

5. If the custom of depositing savings with banks were generally adopted by natives of India, I calculate that they would in the aggregate be richer by about Rs. 1 crore per annum. This is computing deposits at an average of R. 1 per head only, and allowing for an average return of interest at 3 per cent.

DISCUSSION.

The Chairman, in opening the discussion, said the paper was a most interesting and suggestive one. His own experience of Indian banking was limited, and only derived from observation in this country, while his knowledge of India was due to five years' work at the India Office. The pleasure of visiting the country had so far been denied to him.

The paper was divided into two parts, the first dealing with the question of Indian credit generally and the position of that credit in this country, and the second devoted to the question of banking. The author had alluded to a set-back in Indian credit in London, and had referred to the opportunities afforded by India for the investment of British capital, being of opinion that those opportunities were not taken advantage of to their full extent. He did not altogether agree with Mr. Murray that there had been such a set-back in Indian credit. The price of India stock no doubt had fallen considerably, like all other gilt-edge securities, but he did not think the price of Indian sterling Stock had fallen more in proportion than that of British Consols. If there had been a set-back in credit it was due to many causes which affected securities generally, and not those of India alone. He did not think personally that the unrest, of which the newspapers had made the most, had affected the minds of investors to any great extent. In order to develop the resources of the country the Government had had to borrow very freely during the last few years, and the proceeds of those loans had been devoted to a great extent to the construction of railways, but the loans had been well taken up by the British public, and were held not for the purpose of speculation but for investment. He had no doubt that in any future issues the Government of India might make, there would be plenty of capital found for Indian enterprise, as long as the public was satisfied that the loans were really used for the construction of railways and the development of the country. With regard to the opportunities for investment in commercial directions, he did not think they had been offered to the public to such a large extent as they might have been. He did not remember having seen a prospectus of Indian industrial undertakings. It might be the duty of the bankers themselves, if they wished to foster such enterprise, to bring it before the public in a proper way, and he had no doubt then that the capital would be forthcoming. The fixed price of the rupee, which he was glad to say had withstood the hard and difficult times of two or three years ago and proved its stability, would also tend to move capital into India provided that opportunities were given. There had not been a fair chance yet, because, owing to the conditions of the money market, due to the Boer War and other causes, the value of money on this side had often been higher than the value of money in India, and naturally money had remained in this country instead of being invested in the East. Given another set of conditions and a return to cheaper money, he thought money would flow into India. As to the progress of banking generally, the author had pointed out the great progress that had taken place and the advantages offered to the trade of the country. He should like to have asked the author many questions on the matter if time had permitted answers to be given. For instance, he should like to have known something about the relations subsisting between the exchange banks and the Presidency banks; whether the Presidency banks acted in the same way as the Bank of England did towards the other joint-stock banks in this country; whether they kept balances with the Presidency banks, and also what their own rules as to the conduct of business were; and

whether they kept a fixed proportion of cash against their deposits. The difference between British banking in India and native banking also he should like to hear explained; to know whether the native banks were conducted on different principles and what the distinction was between the two, if there was any distinction at all. He was particularly struck with the success of the banks. The management being in India and the boards in London implied that a great deal of initiative and responsibility were in the hands of those to whom the institutions were entrusted. He thought it was a good system that the responsibility should rest on the executive officer, with a supervising board behind him. It developed strength and independence of character, and that capability of dealing with difficulties which marked the very highest qualities of mind. He believed that the Indian bankers were some of the best bankers ever seen. It was only another development of the administration of the country generally, an administration in the hands of responsible officers, unfettered but responsible to their superiors. While the author had spoken of the success of the banks, it should be remembered that the success had not been always unchecked, and one would like to hear of the disasters and the causes that brought them about; for instance, what really led to the downfall of the Oriental Bank, one of the most powerful institutions existing at one time. A good deal had been heard of the cry that India was short of capital, and that might be true. It was a cry he always liked to hear. He was always delighted when he heard there was a great deal of congestion on the railways, because where there was congestion there was business, and where there was business there was always a cry for fresh capital. That was what had taken place, and what he hoped would take place in the future. The author had said that banking in India was only just beginning; he quite agreed with him, in fact he believed that the trade of India generally, and the welfare of the country, was only in its infancy. Given a period of rest and freedom from political agitation both in India and at home, he felt confident that, with the development of the railways, with the benefits bestowed by irrigation, with the care of the Government for the well-being of all classes, the commercial development and prosperity in the next ten to twenty years would be such as was almost undreamed of at the present time. He believed the possibilities of the development of India were as great as, if not greater than, those of any of the British colonies, all of which gave such great promise for the future.

Mr. H. M. Ross did not think the author had exaggerated the importance to India of the extension of banking, and there was ample scope for the employment both of the gold capital of this country and of the funds which the banks would be able to command locally. Apart from the unrest question—which he agreed in regarding as a transient one—there could be no doubt that the employment of gold capital in India would depend upon the maintenance of the gold standard, the establishment of which had placed the trade and the banking of India upon a new and secure footing. The author's residence in India embraced a period before and after the change of standard, and his experience of a banker's anxieties in the early part of that period must still be fresh in his memory. For his own part, he should never forget the troubles of a merchant at the time when, as Mr. Murray so aptly expressed it, the violent fluctuations in the sterling rate of the rupee made trade in India more subservient to exchange than responsive to supply and demand. The progress and prosperity of banking in India had been extraordinary. About the time of the closure of the mints the £20 paid-up shares of the Chartered Bank of India, then established for forty years, stood at £18; fourteen years after the closure, in 1907, the shares were sold as high as £70. The National Bank of India had in the past few years distributed in the shape of bonus-shares to its shareholders a sum equivalent to 60 per cent. of its original share capital, and at the same time had paid handsome dividends year by year. With such remarkable results it seemed very strange that the great significance of the proposed change of standard of banking in India was not at first appreciated by bankers themselves. With one or two exceptions they lent little or no countenance to the agitation for the closure of the mints. Of course the first essential of sound banking was prudence, and a banker who was likewise an agitator was no doubt a dangerous man. The author had hazarded a prediction with regard to the future of banking in India which the Chairman had thoroughly endorsed. Banking in India would increase enormously with the development of the vast natural resources of the country, and in such a development banking would play its part. The extension of banking in India would be materially assisted by facilities for obtaining funds in the cheapest market, and that at times would mean the English market. This necessitated the absolute maintenance above all doubt and suspicion of the gold standard. None, he thought, were more conscious of the vital importance to India of the maintenance of the gold standard than Sir Felix Schuster and his colleagues on the Council of India, and it was with the utmost confidence that responsibility might be left to them for the maintenance of that standard. The author had mentioned an alternative to the employment of gold capital by making local hoards and resources available by an extended system of banking. In a letter appearing in the *Times* about two years ago, and endorsed by the paper in a leading article, his friend Sir Ernest Cable, of Calcutta, urged the desirability of usefully employing the vast hidden wealth of India. He did not know that it was economically correct to speak of the precious metals as wealth, but they could be exchanged for wealth. For years India had been absorbing the precious metals, and despite the improvements in

banking, was taking more than ever before. Of late years the net imports of treasure had averaged over twenty millions sterling. That might be a proof of increased prosperity, but it was also a proof that vast numbers of the population of India still knew no better method of disposing of their savings than by investing them in gold and silver. He had read lately in a circular of a London bullion dealer that precious metals were a necessity in India, not a luxury. But they were a necessity just because of the ignorance of the population, and that ignorance banking might do something to correct. A good deal had been heard about the drain of wealth from India, but in his opinion the real drain of wealth from India lay in the fact that year by year she parted with large quantities of her valuable products in exchange for a mass of metal of which she made no use. It was, however, a matter for thankfulness that there was no chance of the inborn habits of the natives of India being changed very suddenly. If, in the course of a few years, they reversed the practice of centuries, by ceasing to import the precious metals and throwing large quantities of past accumulations on the market, it would certainly be very unwelcome, because there would be no knowing to what depths of depreciation the precious metals might go. The maxim, "look before you leap," quoted by the author at the conclusion of his paper would be an admirable maxim for the Government of India to consider when it had before it a Bill for giving a guarantee to joint-stock banks for lending their funds to agriculturists.

Sir JAMES WILSON, K.C.S.I., said he had not much knowledge of joint-stock banking, but he had had occasion to study the question of banking in India from the point of view of the agriculturists, and had often to consider how best to supply the agriculturists with the capital required to carry on agricultural operations. In the Punjab the ordinary rate of interest that had to be paid by a small peasant for petty loans to enable him to tide over a bad season or sow his grain was something like 20 per cent. per annum, and in some other parts of India it was reported by responsible officials that something like 37 per cent. per annum was the usual rate of interest paid by the peasant for petty loans. In other parts of India it was a good deal less. In Guzerat the agriculturist could often borrow for 10 or 12 per cent. A very large proportion of the agriculturists required to borrow money to carry on their work, and a high rate of interest was a tremendous burden on the prosperity of the small holders. In the Punjab there were something like one and a half millions of men owning rights in the land and cultivating the land themselves, and he had roughly estimated that the amount of money which they had to borrow every year in the Punjab alone was something like ten millions sterling. The population of the Punjab was about one-fifteenth of that of India, so that according to that estimate the small agriculturists of India had to borrow something like 150 millions sterling every year and pay 15 or 20 per cent. interest upon it. Those figures lent support to the author's prognostication that banking in India was still in its infancy, notwithstanding the wonderful progress already made. With regard to the amount of capital available in India to finance not only agriculturists, but all industrial and commercial businesses, he had seen estimates of the amount of gold and silver collected by the Indians and hoarded within the last 100 years, and he thought he was within the mark in saying that there must be 400 millions sterling of gold and silver either used in the form of ornaments or for currency, including 200 millions of gold and silver hoarded away. If the people could only be persuaded to lend the money instead of burying it in the ground, that gold and silver alone would probably be enough to finance all that India required without any help from outside at all. There were indications that the Indians were becoming more ready to trust their money to other people. As the author had pointed out, the money invested in Indian stock had increased considerably within the last ten years, and there was also an increase in the circulation of currency notes, which meant that people were more ready to take as money a bit of paper signed by the Government. There was no fear, however, of the whole population of India suddenly throwing 100 millions of gold and silver on the world's market—it would be a gradual process. He would like to see also a development of the banking system, which meant an extension of credit. He was glad to see that the number of small joint-stock banks was increasing and that the Punjab took the lead in the matter. He had been watching the growth of the small joint-stock banks in the Punjab, which were mostly managed by Indians, and there was a great danger that men who were not capable of managing a bank would start them and that credit would suffer by the bursting up of small banks. He agreed it was time the Government took steps to save the shareholders and depositors, and even the directors themselves, from the consequences of ignorance. Perhaps the best plan would be to lay down a limit that the deposits must not exceed so many times the amount of the paid-up capital; and also there should be a law to the effect that no bank with a paid-up capital of less than a lac should go on without a compulsory Government audit. It was not necessary to apply a compulsory Government audit to the well-established large banks, but the small banks should be looked after in that way. The author and he had had the advantage of serving on the committee which first drafted the Co-operative Credit Societies Act, and he himself had been able since to do something to foster the movement. He was chairman of the first meeting of registrars of co-operative credit societies and had had also to look after the actual working of the societies in the Punjab, and he rejoiced to see how very rapidly the movement was growing in India. It had caught on and promised to be an enormous success and of great advantage to the small peasant

proprietors. Although the Act was only passed about six years ago, there were already 2,000 co-operative credit societies in working order with 200,000 members. They were managed by the people themselves. That movement could not have gone on without assistance from the Government, and the chief assistance was rendered through the registrar, who was a Government officer, and mainly through a free audit. Every little society had to send in its accounts to the registrar, and he or one of his staff visited the village and went through the books and checked the whole of the work of the bank. The consequence was that not one of the societies had failed in such a way as to cause loss to anybody. In the Punjab the society generally lent to their members chiefly for productive purposes at something like 9 per cent., whereas the village moneylender used to charge 20 per cent. or more. Each man was interested in seeing that the borrower, his fellow-member and neighbour, paid up, and there had been very few bad debts. The movement promised to have a very excellent effect in supplying capital at a low rate of interest to the small village communities. The joint-stock banks could undoubtedly help in that direction by lending money to the co-operative societies, and one of the joint-stock banks in the Punjab said they were willing to advance a considerable sum at 6 per cent. to any society the registrar thought might safely be entrusted with the money without any guarantee from Government. He was very much in favour of co-operative societies, but much opposed to any suggestion that the Government should guarantee advances, because that would destroy the whole principle of the movement, which was to encourage thrift and good management and honesty amongst the people.

The CHAIRMAN, in moving a vote of thanks to the author, said that one point of difference between them was that Mr. Murray said it was the business of companies to borrow and the business of banks to lend. It was, however, too often forgotten that, of all borrowers, banks were the greatest. A bank's business was to borrow first in the shape of deposits and then to lend, and it could only lend as long as it borrowed. In any legislation that was attempted—he did not believe in very much legislation on banking matters—it had to be borne in mind that the very essence of a bank's business was to borrow money from the public in the first place. With regard to registration and audits, one of the great objections to a Government audit was the creation of a false feeling of security. A Government audit might be very useful in detecting mischief, but it should not create a feeling in the minds of the public that, because an institution had had the benefit of a Government or official audit, all was well. An audit was extremely valuable, but it could not be taken to guarantee the absolute safety and well-being of any institution. Therefore, if Government inspection implied more than that, generally speaking, everything was in order and fairly properly kept, as far as the books showed, there would be a great danger in such a step. The public had to learn to distinguish between banks and banks, and between institutions that were well managed and those badly managed, and they had to trust those who were in charge of them.

Sir WILLIAM LEE-WARNER, G.C.S.I., in seconding the motion, said the guarantee the Government could give was for the maintenance of peace within and without India, the guarantee of justice, and a guarantee not to meddle with other people's business. He trusted those were the only three guarantees the Government would give either to co-operative banks or any other banks, or any business private or otherwise. He had felt considerably cheered by the paper that had been read, because he felt there was a great scope for development in India. He believed the longer the British were in that country the more hoarding of gold and silver there would be, but that hoard would take new directions, *e.g.*, pictures, fine buildings, etc. He also wished to thank the Chairman for coming at a great sacrifice of his time to preside over the meeting, and he could assure Sir Felix Schuster that he would have even a heartier welcome the next time he came.

The motion was carried, and the meeting adjourned.

In reply to the discussion, Mr. MURRAY writes:—I am exceedingly glad to receive Sir Felix Schuster's assurance that India's credit in the City of London is as good as he states, and I trust his remarks will be noticed by the general public and their prejudices removed. With reference to his questions, the Presidency banks of India do not control the money market as the Bank of England does; but as all banks and large mercantile firms, municipal port trusts, and other public corporations, the administrator-general and official trustee, and numerous private persons in all towns where Presidency banks have offices, deposit a considerable portion of their daily surplus cash with those banks, and as the latter publish weekly statements of their assets and liabilities, they indicate the state of the money market. Then, as Council bills are paid through the Presidency banks, and they are the principal depositary for gold coin and cash, they are necessarily the chief distributors of currency, and thus the indication which they give of the position of the money market is approximately correct. The Presidency banks allow no interest on current accounts; other banks in the coast-port towns allow 2 per cent. per annum on daily balances from Rs. 1,000 to Rs. 100,000. The Presidency banks, under their charter, are restricted from dealing in foreign exchange (Ceylon excepted), except for remitting their customers' money and covering dividends payable at Coutts' Bank in London.

There is no fixed proportion of cash retained against deposits, but all the banks, Presidency, exchange, and local, make a practice of holding not less than 25 per cent. in cash.

Native joint-stock banks are understood to be worked upon the same general principles as European banks, except in some instances in which trading is combined with banking. The class of investment varies with the district in which the banks are situated. European banks do not as a rule lend upon mortgage of immovable property, but the nature of the trade and industries necessitates more loans of a fiduciary character than is probably customary in London.

The failure of the Oriental Bank was the result of bad debts, incurred principally in Ceylon. The bank had been the chief support of the coffee planters, and from advancing in growing crops, they went further and advanced on the estates. The leaf disease ruined the coffee planters, and the bank was too seriously involved to stand against its losses.

I do not think, though I express myself with diffidence in the presence of such a high authority, that deposits with banks can be classed in the same category as loans to trading companies. Money at short call may be so classed, but except in the Presidency towns during busy seasons, such deposits form a small portion of the deposits in India. The ordinary deposits are made, not as loans, but for the convenience and security of the depositors. Moreover, in the case of current accounts, they return little or no interest. My point is that in India, where the people, other than Europeans, are only just being encouraged to recognise the convenience and security which deposits with banks afford, it is of some importance that they should not receive discouragement, and with so many new banks springing up, many of which must necessarily be under inexperienced management, it is to be feared that banking enterprise may receive a check unless some regulations are made for the protection of depositors. I feel sure that it would be acceptable to the banks generally, and would not fetter legitimate business, if they were compelled by Act of Council to keep an adequate reserve in cash against their deposits, and if new banks were restrained from receiving deposits until a sufficiency of capital for banking purposes had been not only subscribed but paid up.

Referring to the remarks made by Sir James Wilson and Sir William Lee-Warner, I fully appreciate the objection to Government guarantees as a general principle, but in this instance co-operative credit societies stand in a similar position to railways, which are guaranteed. Their object is to increase cultivation, and with the attainment of that object the Government revenue will be increased, and the condition of the people bettered. The risk is balanced by the prospective benefit, and the benefit is of a kind which will be greatly enhanced by quick attainment.

EIGHTH ORDINARY MEETING.

Wednesday, February 1st, 1911; the Right Hon. the EARL OF CROMER, G.C.B., O.M., G.C.M.G., K.C.S.I., C.I.E., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Bell, A. Mitchell, 56, Stanley-road, Halifax, Yorks; and Municipal Technical College, Halifax, Yorks.

Hill, W. Hereward, Canton, China; and Fairmount, Sidcup, Kent.

Hope, William Henri, The Studio, South Croydon, Surrey.

Miles, T. R., 9, Brighton-terrace, Brixton, S.W.

Osman Sahib, Khan Bahadur S.M.V., B.A., B.L., Presidency Magistrate, Madras, India.

Pillai, Perumana Narayana, Kayangulam, Travancore, India.

Sykes, John Guttridge, 88, Marlcliffe-road, Hillsborough, Sheffield.

Young, Rev. William Edward, Brook Lawn, Queen's-road, Teddington.

The following candidates were balloted for and duly elected members of the Society:—

Armsby, Henry Prentiss, Institute of Animal Nutrition, Pennsylvania State College, State College, Pennsylvania, U.S.A.

Beaumont, Frederick, 6, William-street, Lowndes-square, S.W.

Bebb, Charles H., Denny Building, Seattle, Washington, U.S.A.

Blain, Alexander W., M.D., 1105, Jefferson-avenue, Detroit, Michigan, U.S.A.

Chirol, Valentine, Queen Anne's-mansions, Westminster, S.W.

De Wardt, John Isaac, 82, Pelham-road, Gravesend.

Dowding, J. C., Chinwangtao, North China.

Eyde, Sam, Sommerrogaden 15, Christiania, Norway.

Fahy, John Thomas, A.M.I.E.E., New Zealand Railways, Wellington, New Zealand.

Finn, Herbert J., 23, Sandgate-road, Folkestone; and c/o The Modern Gallery, 61, New Bond-street, W.

Flower, Charles E., Warborough, near Wallingford, Oxon.

Hogg, Rev. William Charles, 116, East Third-street, Williamsport, Pennsylvania, U.S.A.

Kakting, Robert, c/o Messrs. O. W. Lindholm & Co., Vladivostock, Siberia.

Kean, Athelstan Joseph Alexander, P.O. Box 50, Guanajuato, Guanajuato, Mexico.

Lord, William Henry H., A.R.C.A.(Lond.), 24, The Pavement, Clapham Common, S.W.

Mackenzie, Roderick D., 9, St. Paul's Studios, Colet-gardens, West Kensington, W.

Martin, Miss Cicely Bridget, 3A, Church-road, Upper Norwood, S.E.

Menzies, Dr. F. N. Kay, 79, Davies-street, Berkeley-square, W.

Millar, Alex. H., LL.D., F.S.A.(Scot.), Rosslyn House, Clepington-road, Dundee.

Millar, F. Grahame, Tangga Batu Estate, Malacca, Straits Settlements.

Newman, Miss Florence, Garlinge, 14, Templar's-avenue, Golder's-green, N.W.

Pannett, Robert Elliott, J.P., Whitby, Yorkshire.

Peat, William Barclay, F.C.A., 11, Ironmonger-lane, E.C.

Powelson, W. V. N., 60, Wall-street, New York City, U.S.A.

Quinton, Alfred R., Westfield, Salisbury-avenue, Church End, Finchley, N.

Sunder, Donald Herbert Edmund, F.L.S., c/o Messrs. Grindlay & Co., Calcutta, India.

Tatlock, Miss H. H., 16, Park-square, Regent's-park, N.W.; and Bramfield House, Halesworth, Suffolk.

Tower, His Excellency Reginald T., C.V.O., Traveller's Club, Pall Mall, S.W.

Waley, Alexander Simon, 32, Rue Spontini, Avenue du Bois de Boulogne, Paris, France.

Westervelt, William Young, 100, William-street, New York City, U.S.A.

Whittemore, Harris, Nangatuck, Connecticut, U.S.A.

Youngman, Miss A. M., R.I., Porton, Salisbury, Wilts.

The paper read was—

EXAMINATIONS IN THEIR BEARING ON NATIONAL EFFICIENCY.*

By P. J. Hartog, M.A., B.Sc.

May I begin with a personal explanation? What I have to say to-night is said on my own behalf alone, and no one else in the university which I have the honour to serve must be regarded as committed in any way to agreement either with my main thesis or with any incidental opinions I may express.

To avoid all possible misunderstanding, I shall state my position at the outset. I desire to appear neither as counsel for the plaintiff nor for the defendant in the great controversy on examinations which has raged intermittently for more than half a century in this country, as in other countries, but rather as one of the public, deeply interested in the issues, and trying to see clearly through the heat and dust of the conflict.

It is often said, and generally accepted, that the whole of English education is controlled by the examination system. It is well, however, in dealing with educational questions, to keep somewhere in the back of one's mind the fact that there is another kind of education than the education of the schools, the education that Mr. Samuel Weller's father gave him when he let him have the run of the streets and make shift for himself; well to remember that there is one branch of the national activity, not the least successful or important—I mean its commerce—which up to the present has been but little affected by examination-ideals; and that our agriculture and industries have been affected by them only to a minor extent. Our business, our agriculture, our industries, have to a large extent "shifted for themselves," I will not say without the help of school teaching, but very largely without the help of examinations.

But the public demands that persons on whose services it relies, but for whose failures it cannot be compensated, as by a business man who fails to fulfil his contract, that these should produce some certificate of competency based on an examination, and often on a series of examinations beginning in childhood, and prolonged into early manhood and beyond. Teachers, lawyers, doctors, dentists, engineers, architects, and the civil, naval and military servants of the Crown, on whom the organisation and defence of the Empire rest, must pass examination tests, and in many cases their whole career is determined by such tests.

It is, therefore, a matter of national and Imperial concern that this method of test should be wise in its design, certain and not capricious in its working, and, above all, that in its stamping operations it should not damage the human material on which it sets a hall-mark.

Can it be said of English examinations at the present day that they fulfil these requirements? Are they wisely designed? Do they work with certainty and accuracy? Do they tend, on the whole, to improve the boys and girls, the men and women, whose education, whose lives and careers they so largely control? Are they really serving the national and Imperial purposes they are supposed to serve, in the best possible way? If these questions were put to a Referendum, I have little doubt of the reply.

While it may be conceded that there are many judicious examiners, and examining bodies

* I have made considerable use in this lecture of the article on Examinations by my friend, Mr. Arthur Watson, and myself, just published in the eleventh edition of the "Encyclopædia Britannica." The reader interested in the subject should refer to a largely-signed protest entitled "The Sacrifice of Education to Examination" (by no means out of date), with replies thereto, published in the *Nineteenth Century* for November and December, 1888, and republished later by Auberon Herbert (Williams & Norgate, 1889).—P. J. H.

of unquestioned wisdom, the body educational as a whole is suffering from the aches and pains of examination. Those who say, "Get rid of examinations altogether," offer us nothing in their place; they do not realise the situation. I spoke just now as if examinations affected us only from without; but have not examinations become, as it were, an artificial nervous system of our education, of which every movement is controlled either by their stimulus or by their power of inhibition, so that extirpation is an impossible task? If we cannot remove this tyrant that governs education from within, cannot we either reduce its powers or force it into beneficence? Quixotic as it may seem, I believe the task not to be impossible.

The task demands inquiry—and by inquiry I mean scientific investigation — patience, and perhaps some drastic reform later. My object to-night is to suggest, first of all, the outlines of an inquiry into our examination system, its design, its methods, and its results; and I shall use the word "examination" to mean a systematic test of knowledge, and of either special or general capacity or fitness, carried out under the authority of some public body.

First of all, the design of examinations. We cannot understand that design without one word as to their history and their original function. The origin of Western examinations —I say nothing of those Chinese examinations which date back three or four thousand years— is sufficiently well known to the historians; they are derived from the examinations of the mediæval universities. Those universities were corporations of teachers and students, analogous to the trade and craft gilds of the time. In the gilds there were apprentices, companions, and masters. No one was admitted to mastership until he had served his apprenticeship, nor, as a rule, until he had shown that he could accomplish a piece of work to the satisfaction of the gild. The object of the university was to teach; its scholars, bachelors or pupil teachers, and masters or doctors, corresponded roughly to the three classes established by the gilds, and the master or doctor (two terms at first equivalent) was one who, having served his apprenticeship and passed a definite technical test, had received the *licentia docendi* —the permission to teach. The candidate was required to teach in public at the examination precisely as he would be required to teach later in the schools. The examination fulfilled exactly the technical purpose for which it was intended. We are apt to think of the schoolmen and all their ways with a contempt inherited from the days of Bacon and Descartes; but in discussing examinations of this kind, that distinguished historian of education, the late Professor Paulsen, of Berlin, asserts that they were well adapted to increase a student's alertness, his power of comprehending new ideas, and his ability quickly and surely to assimilate them to his own; and that they did more to enable students to grasp subjects than the mute and solitary reviewing and cramming for our modern examinations can possibly do. The limitations of the test were the limitations of the educational and philosophic ideals of the time. At their best, as I say, they did exactly what they were required to do. At their worst, says Canon Rashdall, they were less of a farce than certain English University pass examinations almost within the memory of persons now living.

To trace the history of Western examinations from their origin to our own time would require us to follow up the ever-changing course of educational ideals with the development of modern societies through seven centuries, and the manifold actions and reactions during all that period between education ideals and examination ideals. For such a task we have not even the materials prepared; but, remembering that the original examination was a test of technical efficiency, excellently suited to its purpose, we can see how examinations have taken on two, and perhaps three, entirely new functions, and with far-reaching effects both on examinations and on education.

The first new function—the use of examinations to distinguish between candidates of different merit—was an early and almost inevitable development; and yet we can see every day how the competitive idea leads us to forget the distinction between the efficiency of an examination and its difficulty. It is constantly said by examination-enthusiasts: "This examination is a superior examination to that, because it is harder to pass." Should we not rather ask: "Is the man who passes it a more useful member of society?" In examinations professedly technical, like the original examinations, this question is of the utmost importance. The main question there is surely not which candidate can do the most difficult things, solve the most Chinese of puzzles, remember the most unrememberable of formulae, but, is the examination helping to turn out the best teachers, doctors, engineers, industrial botanists, industrial chemists? In other

examinations, like the highest Civil Service examinations, the element of pure difficulty, on which I shall have a word to say later, may appear in another light.

The second new function of examinations is a later development, and in some ways a characteristically, though not exclusively, English development—I mean their use to test not so much the efficiency of candidates as that of their schools. The external examination of schools and of school children, begun by the College of Preceptors in 1853, and now carried out on an immense scale by the College and by other bodies, mainly university bodies, all over the United Kingdom, had primarily for its object to distinguish between the sheep and the goats of the private schools. The examination, as thus used, was organised primarily as a technical test, good or bad, not of the taught, but of the teacher. But are not the real interests of the taught, which it was originally intended to serve, sometimes, or perhaps often, lost sight of in the process? Here, again, the difficulty of an examination is apt to be confused with its efficiency.

There is a third function of examinations, not easy to distinguish altogether from the original function of testing efficiency—I mean their function to test what is called "general culture." In dealing with this question, we find a certain amount of common agreement as to what is the best policy, combined with a powerlessness to carry out that policy in the face of our present organisation of examination and education, and our refusal in education to remember the wisdom of leaving some things the time and opportunity to "shift for themselves."

It will, I think, be generally admitted that culture is something more than the knowledge of the best that has been thought and said in the world, according to the definition of Arnold, unless knowledge is used with a far wider connotation than is possible in the examination room—something perhaps more personal and sensitive than the "enlargement" which John Henry Newman contrasts with knowledge. I shall enter into no rivalry of epigram with these great masters of style, but I think, on cross-questioning, we should find that the cultured man is the man who is sensitive and responsive over a large field of knowledge regarded as of value by the community. On cross-questioning we should again find it generally admitted that that sensitiveness and responsiveness are apt to suffer injury by the drastic concentration required for the examination syllabus; at every step the delicate feelers of the mind are paralysed by the suggestion: "I am wasting my time in going further; that won't be asked." It may be held, and I should agree, that culture is as individual a thing as conscience; that culture may be killed, that it cannot be caught, by examinations. Yet teachers who realise all this, who think examinations in their subject mischievous rather than helpful, implore the authorities to include it in every possible examination syllabus. Why? Because, under the present *régime*, a subject that is not examined in is likely to disappear speedily from our teaching curricula. That point is sufficiently illustrated by the controversy on examinations in Greek.

We have thus seen that examinations are nowadays conducted with four distinct, primary objects:—

(1) To test the efficiency of a person for the practice of his technical calling or profession.

(2) To arrange candidates in an order of merit.

(3) To test the efficiency of schools.

(4) To promote general culture, an object for which many persons regard them as totally unsuited.

I am quite aware of the complexities of the issues raised by this simple classification. A recent writer, dealing with the same problem from a different point of view, has made out a list of seventeen qualities which an examination can test, and thinks his list might be extended still further. My classification deals only with groups of such qualities, and the grouping will vary with the specific object of an examination. I think it quite possible that I should find it difficult to conciliate all my critics, and most of all those who are partial to the examinations in Class (4) of my list. I am, however, willing, as I said before, to concede that any particular examination, and any particular examining body, may have all the virtues claimed for them; but I would ask of those concerned if it is not a fact that if we took the examination-papers set at many examinations, and inspected them in detail, we should find it an impossible task, from internal evidence, to decide with what object, or with what combination of objects, those examinations are organised. Individual examiners are not asked to bear in mind, nor is it, perhaps, always desired that they should bear in mind, the careers which the examinees propose to follow; they are asked, not to examine with any particular aim in view, but to examine "in

their subject," and this, I suppose, is what is meant by the opponents of examinations when they rail against examinations for examination's sake. Thus I am inclined to think that the most ardent advocate of the examination system would be prepared to admit that the object of many examinations held nowadays is indeterminate. It can scarcely be expected, therefore, that the results will be in all cases precise.

Before we can estimate in detail the results of examinations, we must say something of their methods. Examination tests may be classified in two ways: firstly, according to what may be called their external character, under which heading we may divide them, as usual, into written examinations, oral examinations, and practical examinations; and, secondly, according to a character much less obvious, but more important. They may be divided into:—

1. Knowledge-tests (or memory-tests), which test the power of restating facts and arguments of a kind that may be learnt by rote—*e.g.*, "Describe Joule's experiments on the mechanical equivalent of heat"; "Relate the chief events in the reign of Edward I."; "Write out the 47th proposition of Euclid"; "How is the preposition 'in' used in Latin?"

2. What may be called capacity-tests, which test the power of doing something, of applying knowledge to some definite purpose, *e.g.*, the power of making a *précis* of a written document, of writing a letter or a report on a particular subject with a particular object in view, of translating from or into a foreign language, or of conversing in that language, of solving a mathematical problem, of criticising a passage from a literary work, of writing an essay on an historical or literary subject with the aid of books in a library, of diagnosing the malady of a patient, of analysing a chemical mixture or compound; and (perhaps, the highest form under the rubric) of making an original contribution to learning or science as the result of personal investigation or experiment.

In some cases the category to which a question belongs will depend on the previous preparation of the candidate. If a candidate who is asked to describe the foreign policy of Queen Elizabeth has only had access to text-books in which Elizabeth's foreign policy is treated incidentally in a more or less chronological record of events, he may show considerable capacity in separating out in his mind the threads of foreign policy from the rest, and putting the results of his thinking into clear language; if he has been in the hands of a teacher who has dwelt on the particular question, his reply may show memory or "knowledge" and nothing more. In subjects like political history or history of literature, it appears to me extraordinarily difficult to set questions in papers of the ordinary three-hours type, which shall come clearly under the heading of capacity-tests*; whereas in many subjects the questions may be either knowledge-tests or capacity-tests, and most written examination papers include questions of both types.

The classification which I have here set down, hinted at by Mark Pattison, and no doubt by earlier writers, but perhaps first clearly enunciated in a remarkable but too little-known work by Latham on "The Action of Examinations," published in 1877, obviously does not correspond to a logical dichotomy. The capacity-test of the kind used in examinations does imply knowledge, though the knowledge-test does not imply capacity beyond that of memorising and an elementary (and at times doubtful) mastery of the mother-tongue. It is sometimes said that the memory-tests set at examinations are too hard, that the knowledge, laboriously pumped into the brains of candidates under examination-pressure, escapes rapidly when that pressure has been released, and that if we were to apply the witty definition of education as what remains when we have forgotten what we have learnt, the result of examination-education is nil. It would not be wise to accept that conclusion without reserve. It is, at any rate, true that examiners do not by any means demand that candidates should know everything that they are asked; the ordinary examiner at a pass examination is content if the examinee can answer satisfactorily from one-third to one-half of the questions set. When these questions are memory-tests, the indulgence is surely justified in most cases, although there are perhaps ignorances of fact of a dangerous character to which this leniency should apply. An examiner told me recently that on the ground that a certain candidate had obtained the necessary number of marks in physiology (and I shall come to the question of marks presently), he had been allowed to pass, although he firmly believed that there was air in the left ventricle of the human heart. The examination, I may say, was not a university

* Mr. M. W. Keatinge, in his "Studies in History" (A. & C. Black, 1910, chap. viii.), makes interesting proposals to meet these difficulties.

examination. On the other hand, for some examiners printing might never have been invented, and books of reference might be as costly as they were in the Middle Ages. I shall not be accused of exaggeration when I say that a knowledge of technical terms in foreign languages is sometimes demanded by examiners which would certainly not be expected of candidates in their own language.

In dealing with capacity-tests, the question of leniency and severity takes on another aspect. A boy who can only do right five addition sums out of ten cannot add. A person who reads a thermometer accurately five times and inaccurately five times cannot read a thermometer. A person who understands nine-tenths of the words in an easy passage in a foreign language, with or without the use of a dictionary, and who is at sea in regard to the meaning as a whole, has not brought his knowledge of the language to a useful point. On the other hand, if a candidate can satisfy capacity-tests, if we are able to assert from the definite evidence of the examination room, by his obtaining not 30 or 50, but, say, 80 or 90 per cent. of the maximum marks assigned to such tests,* that he can do this kind of problem in mathematics, that he can speak this foreign language so as to make himself understood on everyday topics, that he can analyse a leading article in a daily paper so as to present its gist fairly and clearly to a person who has not read it, we need not fear that these capacities will fade away a week or a fortnight after the examination.* I firmly believe that examinations *can* tell us something definite about candidates. The question is, do they at the present moment? It is obvious that the answer will not be the same in regard to all examinations, that no general answer can be given to my question. But we shall understand its precise bearing if we deal a little more in detail with the question of numerical marks, adopted, not in all examinations, but in most pass examinations and in most competitive examinations.

The system is familiar to every one. A certain number of marks is assigned to each question set, and the maximum obtainable for a paper is the sum of these marks. The number of marks allotted to each candidate is the sum of the marks assigned to his several answers to those questions; and the ordinary working hypothesis is that the value of the performance of the candidate is proportional to the total number of marks he obtains. Putting the thing in another way, we may say that the hypothesis amounts to this, that, if we arrange candidates in the order of their performance as determined by the aggregate of marks obtained, we shall be doing them no injustice, and this order is commonly called an order of merit (though order of proficiency would perhaps be a more accurate expression).

The value of this hypothesis may be tested in two ways. We may examine the postulates on which it rests, and the results to which it leads. Take, first of all, the postulates. It implies that we have some reasonable basis for determining the relative value of different questions, *i.e.*, that a number of different examiners, regarded as equally competent, will attribute approximately the same relative value to different questions; and it implies again that the same set of examiners will attribute approximately the same values to the answers to those questions given by a particular candidate. Now, although examinations are carried out on such a gigantic scale, we have very few published data to test the validity of these postulates. In a statistical investigation by Professor Edgeworth, it appeared that there were considerable discrepancies in the marks assigned by different examiners to the answers of a set of candidates.* If this is so, how can we maintain the same standard? The result is what we might expect in the case of examinations of which the object is indeterminate, for how can we estimate the value of anything unless we know what is its precise object? If a candidate is allowed to pass by obtaining from 30 to 50 per cent. of marks on memory-tests and capacity-tests mixed in variable proportions, what does a "pass" mean? What may we say that a man who just passes an examination can do? Is not the meaning of a "pass" in itself indeterminate? Does not the standard necessarily vary from candidate to candidate as well as from year to year?

If we turn again to the results of examinations carried on on a large scale, there are indications that the results of this working hypothesis are not more satisfactory than its postulates. Examiners themselves are often heard to say, "This man is better than his marks, this man

* *Cf.* the evidence given by Professor Lippmann of Paris at the *Enquête sur l'Enseignement Secondaire*, conducted by the Chamber of Deputies in 1899, Procès-verbaux, vol. 2, p. 35.

* "The Element of Chance in Competitive Examinations," *Journal of the Statistical Society*, vol. 51, p. 599 and vol. 53 p. 644

is worse than his marks," although perfect freedom may be left to them to assign marks so as to correspond to resultant merit. And if we inspect published statistics of examinations for which a large number of candidates present themselves, and in which it would be reasonable to expect that approximately the same number would attain a pass standard in consecutive years, they show that there may be the most extraordinary variations in the percentage of passes in the same subject. Those variations, I think anyone acquainted with the inner working of our examination system will agree with me in saying, cannot be regarded as due to the carelessness of individual examiners, for, in the first place, examiners take a great deal of pains with their work, and, in the second place, carelessness may tell as much in favour of a particular candidate as against him. I do not think that it is at present possible without further scientific investigation on a considerable scale, to state what are the precise facts of the case, or the precise causes of these variations. They may be due to defects in our system of marking; they may be due to real variations in the quality of candidates, of which the causes are unknown and which it would be important to discover. I want to strengthen my plea for investigation by quoting a witness whom I might have expected to find against me. If there is one subject in which accurate marking and community of standard would appear to be most easily obtainable, it is mathematics; and it seems probable that the whole system of marking by numbers is derived from the marking of mathematical papers. Nevertheless, Professor Bryan,* a distinguished mathematician and a high authority on the subject, regards some of the troubles to which I have referred as due to "fetish-worship" of the maximum mark, and suggests that we should assign certain marks to correct answers of average quality, and then mark up to any maximum we please to reward exceptional proficiency shown on any part of a paper. In this way, he thinks, candidates would no longer feel the inducement to "scramble for marks by scribbling scrappy attempts." Other authorities have suggested different ways of dealing with these difficulties, but it is safe to say that there is no agreement, and that different examiners employ very different methods. The α, β, γ, δ, or Oxford, system is another form of numerical marking in which the total number of marks allotted is low,* and in which, if I am rightly informed, the examiners as a rule attempt to obtain their resultant impression of a paper as a whole directly, instead of by the addition of marks assigned to individual questions. Here, again, it would require investigation to decide whether this system is or is not more reliable than the other. In any case, in determining a man's pass or class, you do not escape entirely from the difficulties involved in the addition of marks. Moreover, the Greek letter system appears, so far as I can see, to be inapplicable to a competitive examination on a large scale in which candidates present themselves in a number of subjects.

The assignment of marks in practical examinations is probably an easier matter than in written, for the reason that most practical examinations, though not all, are capacity-tests rather than memory-tests, and it is easier to say whether a candidate can or cannot do what is required of him.

Of all kinds of examinations, that which may be the most valuable, and that which presents the most difficulties, is the *viva-voce* examination. Largely used abroad, it is used comparatively little in this country, because our boys and girls are not taught to speak and to think at the same time at the age when children speak confidently and easily, and hence in the presence of the examiner the candidate is often paralysed by nervousness, for which it is difficult, or impossible, to make the proper allowance. He may be reduced to silence or nonsense. A candidate in Materia Medica in a northern university, who was unable to distinguish the taste or the smell of the sample of cod liver oil that he held in his hand, on being asked, "Where does cod liver oil come from?" replied, "The whale."

Nevertheless, the *viva-voce* examination has the immense advantage of allowing a reasonable examiner to ask a candidate not paralysed by nerves what portion of a subject he has specially studied, and to cross-examine him considerately in that. The negative evidence that a candidate says nothing in regard to a particular printed question does not carry one very far. The frank "I don't know" of a candidate, his power of distinguishing what he does know from what he does not, will, with an examiner capable of judging men, count very greatly in favour of a candidate whose knowledge of the parts of the

* Articles on "Examinations," by Professor G. H. Bryan, Sc.D., F.R.S., published in the *School World* for May and June, 1910.

* By adding the signs + or − to the Greek letters, the number of symbols used is, as a rule, increased to ten or more.

subjects that he thinks he knows is sound. But a *viva-voce* examination, if it is to be valuable, must not be hurried, and hence it is an expensive form of examination. It has again the defects of its qualities. The idiosyncrasies of examiner and candidate may come into conflict in regard to matters which have nothing to do with the particular examination test. To combat this defect, it is generally recognised that *viva-voce* examinations should, if practicable, be conducted by a board of examiners rather than by a single examiner.

We have in the *viva-voce* examination a sense of reality that is apt to become somewhat thin in the written examination. If an examiner knows that he has to decide, face to face with a candidate, not whether he attains a particular standard in a particular subject, but whether he has the knowledge and capacity to do a particular job or pursue a particular career, he will feel much more able to come to a decision than after he has merely seen the candidate's written papers. Would any sensible person, in business, in war, or in administration, free to choose his own subordinates in carrying out an important piece of work, dream of doing so without an interview, if he could help it? On the whole, it seems to me that our examination system would be more efficient if larger use were made of the oral method than is made at present. But there are administrative difficulties in conducting them not to be under-estimated.

Before leaving the question of examination methods to enquire further into the effects of examinations on the candidates, I want to throw out one suggestion. I believe that we should effect a quiet revolution in pass examinations, but a revolution, if we would systematically ask ourselves in regard to each examination, what does it prove that all successful candidates can do? What are they certainly fit to do? Such a question would put capacity-tests and memory-tests, I believe, in their right places, and the examination would become once more, as in its origin, what the mathematicians call a directed quantity.

And now for the effect of examinations on candidates. If we take a large cold thermometer, as accurate an instrument as you please, and plunge it into a relatively small quantity of warm water, the reading of the thermometer will not tell us directly what the temperature of the water was before we tried to measure it. In the same way, even the most admirably organised and designed examination will generally exercise a very considerable disturbing influence on the previous education of the candidate that it is designed to test, and on the candidate himself during the examination. In the case of the thermometer, we can correct our original reading by making the necessary allowance; in the case of the examination candidate, what correction can we possibly make?

How, if we cannot calculate them precisely, shall we reduce the bad influences and magnify the good influences of examinations as far as possible? It is a grave problem, and we shall find considerable disagreement in determining what features of examinations belong to one category, and what to the other. Let us, for the moment, consider the influence of the examination on the candidate while it is being actually carried on. There can be no doubt that examinations prolonged over several days, for from four to six hours a day or more, involve a considerable physical strain on the candidates, and the sample of the knowledge and capacity which the examination affords can hardly be regarded as an average sample. With some candidates the excitement and strain make them do better than they otherwise would do; with others the reverse is the case. Ought we to try to reduce that strain? A good many, I fear, would not assent. It has been said, and not infrequently said, that if a candidate fails under the strain, he is lacking in some of those qualities which go to make a successful man, and that though failure in the particular examination does not mean (as the public might, and often do, think) that he has not the intellectual attainments of those who pass, yet that no harm is done. It seems probable—one cannot go further than that—that failure in examinations owing to ill-health takes place more frequently in the case of women candidates than men, and the question of women candidates certainly needs separate investigation; but in the absence of adequate statistical and medical inquiry, the whole hygiene of the examination-room remains obscure. Much more important, in the long run, than the immediate influence of the examination-room on the candidate is the influence of his preparation for the examination during the long years of school and university life. That is a subject too complex and important for me to do more than mention; I would only suggest two things—firstly, that in some subjects and with some candidates, the influence of examinations may be good and not bad; and secondly, that instead of encouraging by

means of examination subjects ill-suited for examination tests, we might try to protect them from those tests. I do not say that it is easy, but I think it not impossible.

Let me take the subject of history, which, of all subjects that come under the heading of "culture" subjects rather than "bread-and-butter" subjects, is the most important to the ordinary citizen. Would it not be possible to reduce school examinations in history to a minimum by allowing those who had attended a history class in a secondary school, to the satisfaction of a duly-qualified teacher, to be exempted from any kind of school-leaving examination in history? Of course, it will be said that the standards of different teachers would be different, but are we not inclined to sacrifice on the altar of equality the very efficiency of the teaching that examinations are intended to test? I remember, in a French Lycée, hearing a lecture on Napoleon's *coup d'état* of the 18th of Brumaire given to a class of science boys who were not to be examined in the subject. The lecture was full of warmth and colour, every boy was interested, every boy was listening, and I contrast that with the painful dictation of slow sentences reproducible in the examination-room that I have heard in some English secondary schools. I do not mean that all French teaching of history is good, and that all English teaching of history is indifferent. I believe there is no subject in which more rapid progress is being made in this country. Might not the examining bodies help the history teachers in other and better ways than by inserting history in all their syllabuses, as the teachers seem to desire?

In dealing with this matter, I would suggest that it is as impossible to make certain that every boy or girl who leaves school has an adequate knowledge of history, has a real beginning of historical culture, as it would be to make sure that every boy or girl who leaves school has musical culture or artistic culture. Supposing you do make sure by examinations that the school-leaving certificate implies a certain knowledge of the facts of history, what then? A boy coming out of the examination-room once said to me: "I am never quite sure whether the date of Magna Carta was 1215 and Waterloo 1815, or whether it was the other way about, but I think I have got it right this time." A boy of that kind, even with the more difficult questions set nowadays, might absorb history, but he would never assimilate it, and instead of trying to force him to be cultured in a subject where culture is impossible for him, would it not be much better to recognise his insensitiveness on the historical side, and push him in some other direction? What I have said of history, applies even more strongly to literature. If we could only make up our minds to require real efficiency in one or two subjects, and give our boys and girls the opportunity of learning other subjects, without forcing them mechanically to do so, would not our education become much more effective in the end? Are we not led by the will-o'-the-wisp of general culture into a mire of general inefficiency? I asked a friend of mine who is an experienced examiner what it would be safe to assert of the powers of a student who could just succeed in obtaining pass marks at a pass examination in several subjects. His reply was: "I think you could say that he could pass the examination at the time that he passed it." I went further. "Would it be safe to say that he had any useful knowledge of the subjects of the examination—that he would be fit for any career?" The answer was clearly: "No, you could say none of these things. When you have said that he has passed the examination, you have said all that can be said."

If we turn from pass to competitive examinations, we find that they involve all the same problems, and fresh ones to boot. Here it is well recognised that difficulty may be used as the means, not of testing proficiency in subjects that will be required in later life, but to distinguish different candidates in regard to what is called their "general ability." The great choice of subjects permitted by the regulations for the Open Competitive Examination for the Home and Indian Civil Services sufficiently illustrates this point. That particular examination is one of the very greatest importance. Is it really fulfilling its purpose in the best way possible? Professor Browne, of Cambridge, in giving evidence before Lord Reay's Committee on Oriental Studies (Minutes of Evidence, page 62), said that, contrary to his expectation, the men selected by the method devised by Lord Cromer, in connection with the Egyptian Services, learnt Arabic more quickly than the men selected by open competition for the Indian Civil Service. I believe Lord Cromer intends to say something later on the methods that he used. I do not say that Professor Browne's isolated observation proves anything conclusive, but it is significant, and points to inquiry.

The tremendous severity of the Civil Service examinations has been regarded as imposing a

sufficient test of the character and of the physical strength required for arduous public service. But do we know at the present moment whether the game is worth the candle? A letter from a candidate who wrote over the somewhat unfortunate signature "Presque passé" in the *Times* of last summer, reminds one uncomfortably of the sad picture of overworked Indian examination students drawn about the same time by Mr. Valentine Chirol in his articles on Indian unrest. Is it not possible to test "general ability," and to separate the ablest candidates by methods involving less strain both on the successful and the unsuccessful candidates? The experimental psychologists and statisticians, working on lines suggested by the late Sir Francis Galton, hold out hopes in this direction, but one must confess that they are still somewhat remote. Would it be possible, without reintroducing the unspeakable evils of jobbery, to follow the lines laid down by Lord Cromer in the Egyptian Civil Service, and by Lord Selborne in choosing candidates for the Navy? These are questions again for inquiry.

Conclusion.

How should such inquiry be carried out? I do not think that any other body than a Royal Commission would carry with it the necessary weight. I believe the Commission should be a small one, presided over by a statesman with great experience of affairs, and that there should be no attempt to achieve the impossible by including in it representatives of all parties concerned. If, following the example set in Professor Sadler's Moral Education inquiry, and in the recent report of the Consultative Committee of the Board of Education on Evening Schools, the evidence taken was published, not in the unreadable and unwieldy form of question and answer, but in the form of statements on particular topics summarised by the witnesses from shorthand notes, after their examination by the Commission, every person and every interest would have a fair say; and the members of the Commission themselves would not have any undue advantage in giving their own summary of the evidence, and their own conclusions. But such a Commission, to do all that it should do, would need to be far more than a Commission of Inquiry in the ordinary sense; it would need to be a Commission of Investigation. It should have the power to appoint and to pay committees of experts in different subjects, who would carry out investigation under its direction. Take the questions of standard and of marking. Those questions it is quite impossible to investigate without having a large number of candidates' answers lithographed and sent to be marked to different examiners, first without directions at all, and secondly with directions in regard to the stress to be laid on particular points regarded as of especial importance. Nor would the expert in his subject alone be necessary; the assistance of the statistician would have to be called in at each step. I believe that in this way we might be able to make an examination standard that would mean something very different from what it means now, that would be reasonably constant from year to year, and that would substitute the fairness of reasoned judgment for the fairness of chance, in the case of far more candidates near the border line. That would be one of the matters for the Commission to investigate. If it were to appoint sub-committees in a half dozen, or a dozen, subjects of examination, the results of the inquiry would probably throw sufficient light on the subjects which it was not possible to touch.

A second question for investigation is the hygiene of the examination-room. How far are we making fair demands on our students in the examinations? How far do they exceed, from the point of view of strain, what it is reasonable to demand?

A third point for inquiry, and that the most difficult, is the influence of examinations, good and bad, on education as a whole. I would only suggest here that different classes of candidates and different subjects require different treatment, and that it should be the object of the Commission to find some way of protecting from examination those school subjects which are unsuited to them, and in which examinations dig up the roots of the plants which we wish to grow.*

Fourthly, the Commission would inquire how far our different sets of competitive examinations select the persons most fitted for the posts which they are intended to occupy.

In this connection, the Commission would, no doubt, consider the question of associating with the experts in their particular subjects administrators with experience of the services for which candidates were being chosen.

I have selected four large topics for inquiry:

* It is understood that the Consultative Committee of the Board of Education are considering the question of school-leaving examinations, but they have not yet issued any report on the subject.

(1) the question of standards and marking, with which is closely connected the question of the precise object of the examination concerned; (2) the hygiene and psychology of examinations; (3) the influences of examinations, good and bad, on previous training; (4) competitive examinations for the Services. But these topics would subdivide, and others would suggest themselves for investigation. A Commission with a suitable reference would find no lack of useful work to do. I suggest as a reference: "To investigate and report upon the methods and efficiency for their purpose of examinations carried on by Government Departments and other public bodies in the United Kingdom; to inquire into the influences of examinations on the previous education of candidates; and to suggest such changes as may seem desirable."

The investigations of such a Commission would be of immense assistance both to the teaching and to the examining bodies of this country. I have tried to obtain figures showing the magnitude of our examination operations. Those figures are still far from complete, but I have official statistics, supplied to me by the authorities concerned, that show that in the year ending September 30th, 1910, out of 146,741 candidates at public examinations in the United Kingdom, 71,114 failed. I have little doubt that when my figures are complete—and I hope I may be permitted to publish them later—the total entries will approach 200,000, and the failures 100,000. Does there not seem to be something very wrong in the relations of our examination with our education for nearly half the persons to be judged unfit to pass the test for which they present themselves? How far is this great percentage of failures due to a low average of intelligence or industry, how far to the fault of the teachers, or the fault of the examiners, or to want of co-ordination between teacher and examiner? Conscientious in their details, have not our examinations been largely at the mercy of hazard in regard to principles?

Lord Rosebery, speaking in 1907 as Chancellor of the University of London,* urged strongly that examiners needed training no less than teachers. He also suggested the need for investigation. For such teaching as Lord Rosebery desires I doubt if any common basis of doctrine at present exists. It must be created.

There is one serious obstacle to change. The examiner and the organiser of examinations are often so weary of their ungrateful tasks that for them the day's work is enough; they become sceptical of improvement, reconciled to evils that they have come to regard as unavoidable evils. But the issues are too grave to be overlooked, and the investigation and reform that I have ventured to demand are a matter of national necessity.

* At the opening of the London Day Training College; see the *Times* of November 4th, 1907.

DISCUSSION.

The CHAIRMAN, in opening the discussion, read the following letter from Professor M. E. Sadler:—

"To my very great regret I shall be prevented from coming to hear Mr. Hartog's paper on Examinations at the Society of Arts next Wednesday evening, owing to an engagement elsewhere which I cannot alter.

"No recent educational event is likely to prove of greater importance than the reading of Mr. Hartog's paper and the discussion upon it. No one in England, or indeed in any part of the world, has given more thought to the problems involved in our examination system than Mr. Hartog, and his acute and practical mind will guide us to a wise handling of the urgent questions which are now beginning to press on us through the excessive development of the examination system.

"Had it been possible for me to attend the meeting, I should have strongly supported the proposal that a small Royal Commission, with groups of scientific assessors, should be appointed to inquire into the question. The time has come for probing the principles of the system, which affects in a hundred ways the intellectual life of the country and its administrative efficiency."

Proceeding, the CHAIRMAN said:—I am sure that you will all agree with me when I say that we owe a deep debt of gratitude to Mr. Hartog for the very interesting paper to which we have just listened. It is a paper which stimulates thought, and, let me add, there are few subjects more deserving of thought at present than that to which Mr. Hartog has drawn our attention. We seem to be about to enter a period during which, whether for good or evil, the State, either in its imperial or municipal capacity, is likely to develop great activity in the performance of a variety of new functions. How are the large additional number of agents whose services will thus be required to be recruited? The results which will be obtained by the new departure now being made will, in a great measure, depend upon the answer which is given to this question. It is perhaps an exaggeration to say with Pope that "Whate'er is best administered is best," but it is certainly true that a good system may be marred by maladministration, whilst the defects of a faulty system may be greatly mitigated if the administration is efficient.

There are, so far as I know, only three methods under which public functionaries can be appointed.

These are election, selection or nomination—the two words are, for the purposes of my present argument, synonymous—and competition, either open or restricted.

I need say but little of the elective method. Its advantages are mainly political rather than administrative. An eminent French economist, M. Leroy Beaulieu, has said:—"According to democratic theory, popular election will always secure the most capable individuals; but this is a curiously mistaken idea, and is quite unsupported by experience."

The Poor Law Commission, over which Lord George Hamilton recently presided, took the same view. "The method of popular election," the Commissioners reported, "is not one which is adapted to get the best administration. The Commission believe that there is a better chance of good administration if the members are appointed than if it is left to the chance of election." I will not, however, dwell any further on this branch of the subject, as it touches the fringe of political issues, which I am anxious to avoid. I will only, therefore, say in general terms, that one, and perhaps not the least important of the questions which the democracy of this country will have to face in the near future, is how to combine administrative efficiency with an adequate amount of popular control. I have often, in the course of my Eastern experience, had to deal with a very similar problem, and I generally found that the question practically resolved itself into this—How much efficiency is it justifiable to sacrifice on the altar of self-government? I came to the conclusion, under the special circumstances with which I had to deal, that it was impossible to generalise on this subject, and that each separate issue, as it arose, had to be decided on its own merits.

Turning to the other alternatives, viz., selection or competition, it may readily be admitted that competition, which is the prevailing system now, has its defects, but before condemning it, it is worth while to glance back at the system which it supplanted. I am one of the band, not now very numerous, who can speak with some personal experience of the pre-competition days, and, as illustrations of the working of the then existing system, I may perhaps be pardoned if I relate a few biographical details. Some fifty-six years ago, being then a boy of fourteen, I was admitted into the Royal Military Academy at Woolwich, with a view to eventually becoming an officer in the Artillery or Engineers. At that time there was a sort of sham entrance-examination, but I never heard of any boy who had been nominated by the Master-General of the Ordnance being rejected. Lord Hardinge, the grandfather of the present Viceroy of India, who was a friend of my family, gave me my nomination. On presenting myself at Woolwich for medical examination, I was very rightly rejected for short sight. I returned to London and told my mother, who was my only surviving parent. She acted with promptitude. She instantly rang the bell, ordered her carriage and went to the Horse Guards to see Lord Raglan, who had succeeded to Lord Hardinge's place, and who was another friend of my family. The result was that next day I returned to Woolwich with a letter addressed by Lord Raglan to the medical officer, asking him to "reconsider the matter." I was, of course, admitted. Exactly the same thing happened at the same time to another lad who was at first rejected on the ground that he had a serious impediment in his speech, but whose case was subsequently, under pressure, "reconsidered." This sort of thing could not happen now. The practical working of the system may, however, best be illustrated by an anecdote which is related of Lord Melbourne. A friend of his who occupied a high position and who disposed of a good deal of patronage, said to him:—"I do not in the least mind confessing that if I had to deal with two candidates, one of whom was the son of a friend or relation of mine, and the other a stranger, I should, *ceteris paribus*, give the appointment to the son of my friend or relation." To which Lord Melbourne drily replied, "So should I, but *ceteris paribus* be damned." In fact, at that time the principle laid down by George III. had only been but slightly modified. That monarch is believed to have said that any one was fit to occupy any place he could manage to get.

Well, ladies and gentlemen, as a result, partly of the attention called to military matters by reason of the administrative breakdown during the Crimean War, and partly of the extraordinary call for officers occasioned by the Indian Mutiny, the nomination system, in so far as appointments to the Artillery and Engineers was concerned, was swept away and the competitive system introduced. It started under rather bad auspices. I remember that the first notice issued by the War Office was rather unfortunately worded. They called for "persons" to compete. The result was that all the young men who responded to this call were instantly dubbed "persons," and commanding officers showed a marked preference for those who had entered under the old system and who had enjoyed the more exalted title of "gentlemen cadets." I was at that time an ardent young Liberal, as I claim to be an old Liberal now, although my right to that designation may perhaps not be recognised by mere party politicians, and I was warmly in favour of reform. As a matter of fact, the gloomy predictions of the anti-reformers were falsified by the event. The social class from which the officers who entered the Army were drawn, was just the same after as it had been before the change of systems, whilst there can be no doubt that a distinct improvement was effected, both in intellectual standard and professional capacity.

I mention these points mainly in order to show that the competitive system, whatever may be its defects, is greatly superior to that which it superseded, and in order to warn the advocates of reform

that they must beware lest a door be opened which may lead to a revival, perhaps in a somewhat different form, of the abuses of the past.

And now let me make a few remarks on the competitive system considered on its own merits. I think the best thing I can do is to deal with facts which have come within my personal experience, and, as you are probably aware, my personal experience has been gained more in the outlying portions of the Empire than at home. I have seen a good deal of the work performed by the young men who are turned out by our universities and military colleges. I have met them on the banks of the Ganges, the Indus, the Irrawaddy, and the Nile. And I have also had some rather exceptional opportunities of comparing their aptitudes with those displayed by their Continental rivals and competitors. From one point of view the comparison is disappointing. I have often had it said to me by heads of departments in Egypt, themselves Englishmen, that the young Frenchman or German came to them crammed to the muzzle with an amount of preliminary knowledge greater than that possessed by the young Englishman. The explanation is, I think, that until of recent years sufficient attention has not been paid in this country to technical education; that is unquestionably a defect, more especially at a time when there is a tendency to specialise every branch of learning, but it is a defect which I hope and believe is in process of being remedied. But if we look at education not merely as a means for storing the mind with knowledge, but also as an instrument for developing the character, the situations are reversed. The youth in whom the need of individual effort and the sense of personal responsibility have been nurtured in one of our public schools or colleges, becomes almost unconsciously *capax imperii*. He is no automaton. In the free atmosphere in which his boyhood and youth are passed, he learns a number of lessons which stand him in good stead in after life as a member of an Imperial race. More especially, he learns not only to think, but, which is much more important, to act for himself—in a word, to govern, and to govern generally with firmness, justice and wisdom. From this point of view our system of making appointments, which is generally, though not exclusively, the result of competition, may, I think, in spite of some defects, be said generally to have produced satisfactory results. A very high authority on Indian affairs, Mr. Valentine Chirol, recently wrote:—"To the Indian civilian belongs the credit of almost every measure passed during the last fifty years for the benefit of the Indian masses, and passed frequently in the teeth of vehement opposition from the Indian politician." I think you will agree with me that this is very high praise. The system has thus turned out a number of young men, who, as the agents of a nation whose very existence depends upon the execution of a sane Imperial policy, are not only of incomparable merit, but, I do not hesitate to add, are also the envy and admiration of the whole civilised world. Whatever changes may in the future be made in our educational system, I most earnestly trust that no steps will be taken which may tend, in any degree, to weaken that sense of independence in thought and action which should constitute the basis of character to the individuals who are the units of any self-governing community.

In spite, however, of this success, I think we may well ask ourselves, after the experience of half a century of the working of the competitive system, whether it is not capable of improvement. The question is certainly worthy of consideration. Remember that the principle of selection, if only it can be properly carried out, possesses merits superior to those of competition. The former may, or ought to result in the creation of leaders of men. It should enable us to acquire for the public service the aristocracy, in the proper and original sense of the term, that is to say, not the aristocracy of birth, but that of intellect and of character. The latter tends rather to produce a dull level of mediocrity. Most educated Englishmen have recently been reading the history, written by a very distinguished contemporary statesman of one of his illustrious predecessors—I mean Lord Rosebery's history of the early life of Chatham. Now, what was it that enabled Lord Chatham to revive British spirit when it had sunk to a very low ebb, to march to victory on the banks of the St. Lawrence and the Ganges, and to found the British Empire? I say that it was the adoption of the principle of selection, sparingly, indeed, but very skilfully employed. I notice with pleasure that of late years there has been a tendency, notably in the military, naval and diplomatic services, to adopt this principle in dealing with all the later stages of the careers of public servants more thoroughly than was formerly the case. I trust that this movement, far from being arrested, will be pushed still further. I could name numberless instances, especially in the military service, in which the dead weight of rigid regulations, based generally on the claims of seniority, have acted detrimentally to the public interests.

The case of first appointments presents naturally far greater difficulties, for, *ex hypothesi*, there can in these cases be no record of past services on which to rely, and moreover, here, and indeed in any application of the principle of selection, we are at once met with the awkward question, *Quis custodiet ipsos custodes?* Who is to select the selectors?

In connection with this subject, there is one point in respect of which I cannot help thinking that a good deal of misapprehension exists. It is not unfrequently thought that Ministers and others in whose hands the bestowal of patronage is vested, would rather welcome an accession to their powers in the matter of making first appointments. I believe this view to be wholly erroneous. My experience has led me to the conclusion that those who exercise patronage are also those who most of all delight in being fettered by regulations

which relieve them of a very irksome and onerous duty, in the exercise of which they are certain to incur a great deal of misrepresentation and abuse, and to receive very little gratitude. It is, in fact, true that the wider is the discretion left to a Minister the more fully will he be exposed to the full blast of social, and also—which is perhaps even more hurtful—of Parliamentary pressure, to make his selections on grounds other than those of merit. Moreover, unless he be an exceptionally strong man, it is well-nigh certain that he will at times succumb to this pressure. More than this, it has to be remembered that neither the action of Parliament itself, in its collective capacity, nor the power exercised by the press, however honest in intention, affords any adequate guarantees either against deliberate jobbing, or what is perhaps a greater danger, against unintentional negligence. The truth is that, save in a very few exceptional cases, the number of persons who can speak with impartiality and full knowledge of the merits of a candidate, whether for promotion and still more for first appointment, is very limited, and, moreover, it is not unfrequently difficult to obtain a frank expression of their opinions. I do not suppose, therefore, that anyone, however fully he may recognise the defects of the competitive system, would be prepared to advocate a return to the principle of uncontrolled selection.

Let me again fall back on my personal experience, and explain how, in one special instance, to which Mr. Hartog has alluded, I solved the difficulty myself. Some few years ago it became necessary to create a Soudanese civil service. In the first instance the appointments were practically made by myself. I found it a very difficult task. I used to receive hundreds of letters from the friends or relations of candidates. Of these about 90 per cent. found their way into the waste-paper basket. I took an enormous deal of trouble to select the best men. Indeed, I may remark incidentally that whatever success has attended the administration of Egypt during the last thirty years has been mainly due to the great care which was taken both in selecting and in promoting officials. Generally speaking, the method adopted in the first instance in the Soudan for making first appointments worked fairly well. Nevertheless, I felt that, apart from the great trouble and responsibility it imposed on myself, the system, or perhaps I should rather say, the absence of system, was very unsatisfactory. In the first place, I never could feel sure that the merits of many young men perhaps more deserving than those who were actually appointed had not been overlooked. In the second place, although I felt quite certain that I should not job, I felt almost equally certain that, sooner or later, I should be accused of jobbing, and the accusation would in itself have done harm, inasmuch as it would have shaken public confidence. On the other hand, I was not prepared to resort to open competition, as I was convinced that many of the qualities most required for a Soudanese civil servant could not be tested by a competitive examination. Eventually a system was adopted under which the duty of selecting candidates who are all taken from the universities was, under conditions which I need not describe in detail, conferred on a board of highly-qualified officials, who were left quite free to act as they thought best in the public interests. The system produced good results, but I do not at all say that on that account it is suitable for general adoption in this country. There are alternatives on which I need not dwell. My present object is merely to draw attention to the subject, and to indicate the advisability of considering whether it is not possible to adopt measures which will on the one hand admit of some independent control being exercised over State authorities, and more especially local authorities in cases where the competitive system, properly so-called, is not applied, and which will, on the other hand, tend to remedy, or at all events to mitigate the acknowledged defects in the competitive system itself. The test supplied by that system, though in some respects valuable, is purely intellectual, and, indeed, as at present applied, it may be doubted, more especially after the evidence adduced by Mr. Hartog, whether, even as an intellectual test, it always succeeds in attaining its object. Time does not permit me to dwell on the details; I will therefore only say that in laying down the conditions under which a competitive examination is to be conducted, the most important points to be considered are, first, how are the examiners to be appointed, and, secondly, on what principles should they proceed in awarding marks.

For the rest, I should like to point out that the Order in Council of 1871 contemplates the possibility of a departure from strict rules in certain cases, but such a departure can only be made with the consent of the Civil Service Commissioners. I believe I am correct in saying that this provision has generally been allowed to remain almost a dead letter. It is in the development of this idea that, for my own part, I should be inclined to look for reform. In any case, I hold a strong opinion that if anything is to be done in this direction, Parliamentary politicians should be rigorously excluded from participation in any boards or commissions which may have the disposal of patronage.

Ladies and gentlemen, I fear I have detained you too long. I trust, however, that this discussion will lead to the matter on which Mr. Hartog has dwelt being considered by others more competent than myself to deal with them.

The idea of appointing a Royal Commission to examine into the whole subject is certainly one which commends itself to me.

[NOTE.—The remaining portion of the discussion, which, in consequence of the threatened strike in the printing trade, has been unavoidably held over this week, will be published in the next issue of the *Journal*.—ED.]

CORRESPONDENCE.

THE INVENTION OF THE PHOTOGRAPHIC LANTERN SLIDE.

The communication, published in last week's *Journal*, from Professor Simon Gage on the early history of photographic lantern slides is of genuine interest, and appeals to all who have made any study of photographic history. Professor Gage has proved beyond all reasonable doubt that the invention is an American one, and he is to be congratulated on the result of his researches.

If any further confirmation was needed, I might add that a little while ago Mr. W. Brooks, who is probably the oldest living photographer, since he is now about eighty years of age, and began his career as a professional photographer in 1849, told me that the first photographic transparencies he could remember were made on albumen, and were shown at the Polytechnic in Regent-street. He added that they were rather dense, as would very likely be the case.

With regard to the application of collodion to the production of lantern slides, a claim may be put in for a photographer on this side of the Atlantic. Professor Gage, in his correspondence with myself, referred to Dr. Neuhauss's "Lehrbuch der Projektion," in which the author says that Dancer, of Manchester, was the first to apply photography to the production of lantern slides. This statement, so far as this country is concerned, is confirmed in the obituary notice of Dancer, which appeared in the "Proceedings of the Manchester Literary and Philosophical Society" (Fourth Series, Vol. I., p. 149). This is merely to the effect that he was the first to suggest the application of photography to the magic lantern, but no date is given. Dancer, who was born in 1812 and died in 1887, was in his time an optician of considerable repute in Manchester. He appears, without much doubt, to have been the inventor of microphotographs, that is to say, photographs on a very small scale used for magnification in a microscope. These scientific curiosities cannot be said to be of any practical value, and, though they were at one time rather popular, I do not imagine that many are now made. The date of the invention is 1853.

Samuel Highley, in a paper read here in 1863, speaks of photographic lantern slides having been constantly made by amateurs, and states that Negretti and Zambra were the first to produce slides commercially. I am also informed by Mr. Freshwater, a member of the firm of Newton & Co., that his firm produced photographic lantern slides at a very early date.

It may, perhaps, never be possible to say whether Dr. Briggs or Mr. Dancer was the first to make lantern slides on collodion (a process which, of course, was for long the usual method of their production), and perhaps it does not now very much matter. As soon as collodion came into use, its application to the production of diapositives was fairly obvious. It seems evident that the invention was made independently by the two men. What is really interesting to know, and this Professor Gage has shown us, is that the invention of the photographic lantern slide is unquestionably due to Langenheim, of Philadelphia, and that the date was 1850. H. T. WOOD.

OBITUARY.

The Rt. Hon. Sir CHARLES WENTWORTH DILKE, Bart., M.P.—The death of Sir Charles Wentworth Dilke, which took place on the 26th inst., at the age of sixty-seven, removes from the list of the Society's members a name which has figured there continuously for sixty-six years. In 1845 Charles Wentworth Dilke, father of the late baronet joined the Society, and four years later *his* father, likewise Charles Wentworth Dilke, was also elected a member. In 1857 the late baronet, then a boy of thirteen, was elected a life member of the Society, and in 1859, his younger brother, Ashton W. Dilke, also became a life member, so that at one period there were on the Society's list no fewer than four Dilkes—three of them Charles Wentworth—all giving as their address 76, Sloane-street.

The second Charles Wentworth Dilke took a very deep interest in the work of the Society. With one short interval, he served from 1846 to 1863 on the Council, of which in 1857-8 he was Chairman. He was a member of the Society's Committee for promoting the Great Exhibition of 1851, and it was in recognition of his valuable services in connection with this and the International Exhibition of 1862 (which was also promoted by the Society of Arts) that a baronetcy was conferred upon him.

From his early years the late baronet was in the habit of attending the meetings of the Society, so much so that a short time ago he said it almost seemed to him that he had been born in the building. He served on the Council in 1869 and 1870, and was a member of the Colonial Section Committee from 1896 to the time of his death. He read two admirable papers before this Section, the first in 1897 on "The Progress of the British Colonial Empire during the Sixty Years of Her Majesty's Reign," the second in 1900 on "The Century in our Colonies," for each of which he received a silver medal; and he also took the chair on several occasions at meetings of the Society.

Of Sir Charles Dilke's political career so much has been written during the last few days that it is unnecessary to do more than recall it in the briefest terms here. Educated privately in boyhood he became a scholar of Trinity Hall, Cambridge, where, after acting twice as President of the Union, he graduated as "senior legalist," or head of the Law Tripos. Soon after leaving college he made a tour round the world, and published the results of his studies and observations in a work

entitled "Greater Britain: A Record of Travel in English-speaking Countries during 1866 and 1867." The book achieved an instant and great success, which no doubt largely assisted in procuring his election to Parliament in 1868 as representative of the new borough of Chelsea. He soon made his mark in the House of Commons, and was looked upon as one of the coming men of the Radical Party. It was on his initiative that the municipal franchise was conferred on women; and in 1878 "Dilke's Act," as it was popularly termed, extended the hours of polling at Parliamentary elections in London. In 1882 he was appointed Under-Secretary to the Foreign Office, and at the end of that year he was promoted to a seat in the Cabinet as President of the Local Government Board. In 1885 the Gladstone Ministry was defeated on the Budget, and Sir Charles never held office again. For seven years he was absent from Parliament, but in 1892 he was again returned as M.P. for the Forest of Dean Division of Gloucestershire, a seat which he retained till his death.

In later years he devoted a great deal of attention to questions of foreign policy and imperial defence. He was also an acknowledged authority on labour questions in general, and some of the recommendations of the Select Committee on Income-Tax, of which he was chairman in 1906, have been embodied in financial legislation.

GENERAL NOTES.

Banking in 1910.—In spite of two General Elections and a postponed Budget, the year 1910 has proved by no means unfavourable to bankers. This, as Sir Edward Holden stated at the annual general meeting of the London City and Midland Bank, was due to the fact that 1910 was a record year for almost every country. International trade exceeded the previous high-water mark of 1907: in our own case, imports and exports, amounting together to 1212 millions, exceeded those of 1909 by about 10 per cent., and those of 1907 by about 4 per cent. In consequence of this general prosperity the profits of the London City & Midland in 1910 would have been record ones but for the fact that surplus profits had been used to write down securities. As it is, the profits amounted to the satisfactory sum of £801,781. Equally favourable are the results shown by the London County & Westminster Bank on the first year's working since the amalgamation of the London & Westminster and London & County Banks. With increased business they have opened fourteen new branches during the year, and, in spite of political disturbances, they are able to declare a dividend of 20 per cent.

Massachusetts and a Nine-hour Day.—It is only recently that a fifty-six hour law came into operation in Massachusetts, and already an agitation has been started for a nine-hours day. A Bill for the reduction of hours to that basis has been determined on by the textile councils of New Bedford and Fall River, as one of the results of a conference. The employers will oppose the change, but their resistance is not likely to be successful, for the State elections have demonstrated the great strength of the labour vote, and that is expected to go "solid" for the Bill.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

February 8.—Captain A. J. N. Tremearne, B.A., D.Anth., "Some Nigerian Head-Hunters." Colonel Sir John Smith Young, C.V.O., will preside.

February 15.—George A. Stephen, "Modern Machine Book-binding." John Murray, J.P., D.L., F.S.A., will preside.

February 22.—Professor J. Wertheimer, B.Sc., B.A., "Water-Finders."

March 1.—Dr. Leonard Hill, F.R.S., "Caisson Sickness and Compressed Air."

March 8.—James Cantlie, M.A., M.B., C.M., D.P.H., "Plague and its Dissemination." Sir Shirley Forster Murphy, M.R.C.S., will preside.

Wednesday afternoon, at 4.30 o'clock:—

March 15.—Colonel Charles Edward Cassal, V.D., F.I.C., "The Adulteration of Food." The Right Hon. the Lord Mayor of London will preside.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

February 9.—R. A. Leslie Moore, I.C.S. (retd.), "Indian Superstitions." Lord Lamington, G.C.M.G., G.C.I.E., will preside.

March 16.—Claude Hamilton Archer Hill, I.C.S., C.S.I., C.I.E., "Education in India."

April 27.—Sir Thomas Henry Holland, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India." Lord Avebury, D.C.L., LL.D., F.R.S., will preside.

May 25.—W. R. H. Merk, I.C.S., C.S.I., LL.D., "The N.W.F. Province of India."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

February 28.—The Hon. Sir Richard Solomon, K.C.B., K.C.M.G., K.C.V.O., K.C., M.A., High Commissioner for the Union of South Africa, "The Resources and Problems of the Union of South Africa."

April 4.—Captain R. Muirhead Collins, C.M.G., "Australia and her Resources."

May 9.—F. Williams Taylor, "Canadian Banking."

CANTOR LECTURES.

Monday Evenings, at 8 o'clock :—

Professor ADRIAN J. BROWN, M.Sc., "Brewing and Modern Science." Four Lectures.

Syllabus.

LECTURE I. — FEBRUARY 6. — Introduction. Dr. Graham's Lectures Thirty-seven Years Ago—The Brewing Process a succession of Complex Biochemical Changes—Barley: Classification of types used by the Maltster—Barley from the Agriculturist's and Brewer's Points of View—Present Position of Knowledge regarding Characteristics of Malting Barley—Results of recent Experiments on Barley Cultivation in Ireland, etc.

LECTURE II.—FEBRUARY 13. — "Malting." Constitution of the Barleycorn — Character of Changes during Germination—Investigations of the Biochemistry of Germination—The Barleycorn a highly-specialised seed, etc.

LECTURE III.—FEBRUARY 20.—"The Mashing Process." The Chemistry of Starch and its Transformation Products—Protein Changes during the Mashing Process.

LECTURE IV.—FEBRUARY 27.—"The Fermentation Process." Previous Treatment of the subject by Dr. G. Salamon in 1888—The Pure Yeast Question in Brewing—Zymase and Modern Views of Alcoholic Fermentation—Nitrogen Assimilation—The so-called "secondary" products of Fermentation, etc.—Conclusion.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 6...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor Adrian J. Brown, "Brewing and Modern Science." (Lecture I.)

Sanitary Engineers, Caxton Hall, Westminster, S.W., 8 p.m. Presidential Address by Mr. A. J. Martin.

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Society of, at the Institution of Electrical Engineers, Victoria Embankment, W.C., 7.30 p.m. Presidential Address by Mr. F. G. Bloyd.

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. W. Woodward, "The Evolution of Fire-Resisting Construction."

Engineers, Cleveland Institute of, Stockton-on-Tees, 7.30 p.m.

Victoria Institute, 1, Adelphi-terrace, W.C., 4 p.m. 1. Annual Meeting. 2. Rev. J. Sharpe, "The Last Century's Witness to the Bible."

London Institution, Finsbury-circus, E.C., 5 p.m. Dr. A. C. Haddon, "The Art of Palæolithic Man."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Professor W. R. Lethaby, "Greek Buildings."

TUESDAY, FEBRUARY 7...Sociological, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Sir Francis Younghusband, "Lamaism in Tibet."

Royal Institution, Albemarle-street, W., 3 p.m. Professor F. W. Mott, "Heredity." (Lecture IV.)

Alpine Club, 23, Savile-row, W., 8.30 p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Photographic, 53, Russell-square, W.C., 8 p.m. Mr. A. E. Salt, "Primary Batteries and Small Electric Lamps for the Dark Room."

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Dr. W. N. F. Woodland, "On the Structure and Function of the Gas-Glands and Retia Mirabilia associated with the Gas-Bladder of some Teleostean Fishes, with notes on the Teleost Pancreas." 2. Professor J. Cossar Ewart, "Skulls of Oxen from the Roman Military Station at Newstead, Melrose." 3. Mr. George P. Farran, "Plankton from Christmas Island, Indian Ocean.—I. On Copepoda of the Family Corycæidæ." 4. Mr. H. R. Hogg, "On some New Zealand Spiders."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. 1. Dr. W. E. Dixon, "The Codex and the Medical Profession." 2. Dr. W. J. Uglow Woolcock, "The Codex and Pharmacy."

WEDNESDAY, FEBRUARY 8...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Captain A. J. N. Tremearne, "Some Nigerian Head-Hunters."

Biblical Archæology, 37, Great Russell-street, W.C., 4.30 p.m.

Geological, Burlington House, W., 8 p.m.

Automobile Engineers, at the Institute of Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Report of the H.P. Formula Committee, with notes by Mr. Dugald Clerk and Mr. G. A. Burls.

THURSDAY, FEBRUARY 9...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Mr. R. A. Leslie Moore, "Indian Superstitions."

Cyclists' Touring Club, Metropolitan District Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. R. D. Maddock, "Cycling in the Swiss Highlands."

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Child Study, 90, Buckingham Palace-road, S.W., 7.30 p.m. Mr. Cecil J. Sharpe, "Recreational Activities: English Folk Dances."

Architects, Society of, 28, Bedford-square, W.C. 8 p.m. Colonel F. S. Leslie, "The Turned Lattice Work of Egypt."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. E. Stanley Roper, "Classical Song."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. P. Chalmers Mitchell, "Problems of Animals in Captivity." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Rev. T. T. Norgate, "On the Edge of the East—Dalmatia, Bosnia, and Herzegovina."

Optical, in the Chemical Society's Rooms, Burlington House, W., 8 p.m. 1. Annual Meeting. 2. Presidential Address on "Astigmatism in Lens Systems."

Electrical Engineers, Victoria Embankment, W.C., 8 p.m. 1. Mr. W. T. Taylor, "Long-Distance Transmission of Electrical Energy." 2. Discussion on Messrs. R. Borlase Matthews and C. T. Wilkinson's paper, "Extra High-Pressure Transmission Lines."

FRIDAY, FEBRUARY 10...Royal Institution, Albemarle-street, W., 9 p.m. Sir Sidney Colvin, "Robert Louis Stevenson."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) (Vernon-Harcourt Lecture.) Mr. W. H. Hunter, "Rivers and Estuaries." (Lecture II.)

Astronomical, Burlington House, 5 p.m. Anniversary.

SATURDAY, FEBRUARY 11...Educational Handwork Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 3 p.m. Presidential Address, by Mr. H. Holman, "Educational Handwork—Some Hopes and Fears."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. T. G. Jackson, "Architecture: the Byzantine and Romanesque Period." (Lecture I.)

Journal of the Royal Society of Arts.

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FRIDAY, FEBRUARY 10, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 13th, 8 p.m. (Cantor Lecture.) Professor ADRIAN J. BROWN, M.Sc., "Brewing and Modern Science." (Lecture II.)

WEDNESDAY, FEBRUARY 15th, 8 p.m. (Ordinary Meeting.) GEORGE A. STEPHEN, "Modern Machine Bookbinding." JOHN MURRAY, J.P., D.L., F.S.A., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURES ON "BREWING."

On Monday Evening, the 6th inst., Professor ADRIAN J. BROWN, M.Sc., delivered the first lecture of his course on "Brewing and Modern Science."

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday afternoon, February 9th, the Right Hon. Lord LAMINGTON, G.C.M.G., G.C.I.E., in the chair. A paper on "Indian Superstitions" was read by Mr. R. A. LESLIE MOORE, I.C.S. (retired).

The paper and discussion will be published in a subsequent number of the *Journal.*

CANTOR LECTURES ON "PYROMETRY."

The Cantor Lectures on "Pyrometry," by Mr. Charles R. Darling, A.R.C.Sc.I., F.I.C., have been reprinted from the *Journal*, and the pamphlets (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John-street, Adelphi, London, W.C.

A full list of the Cantor Lectures which have been published separately, and are still on sale, can also be obtained on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

NINTH ORDINARY MEETING.

Wednesday, February 8th, 1911; CARMICHAEL THOMAS, Treasurer of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Crook, Thomas Mewburn, R.B.A., 10, Gainsborough-road, Bedford Park, W.

Genge, Henry Arthur Pope, Ootacamund, Madras, India.

Green, Richard Crafton, Newport, Essex.

Grundy, Cuthbert Cartwright, R.I., R.C.A., Homefield, Blackpool, Lancashire.

Gummá y Marti, Alfredo, Calle Universidad 30, Barcelona, Spain.

Heys, John, Heysham, Marine Approach, South Shields.

Lawrance, Dilipa John Skillern, 16, Infantry-road, Bangalore, India.

Lawrance, John C. Skillern, B.A., LL.B., Kirkton, 16, Infantry-road, Bangalore, India.

Lloyd, William, 29, Bridge-street, Staines.

Pott, Miss Constance M., 81, Cornwall-gardens, S.W.

Smith, Alexander Monro, 2, Denton-road, East Twickenham.

The following candidates were balloted for and duly elected members of the Society:—

Daneff, St., LL.D., Sofia, Bulgaria.

Forman, Robert Brodie, High Pastures, Elmswood-road, Aigburth, Liverpool.

Gunn, Donald, Hogtrow, Hook Heath, Woking.

Hudson, Philip Reginald, A.R.S.M., 807, Majestic-building, Denver, Colorado, U.S.A.

Lal, Pyarai, Zamindar of Burotha, Aligarh, India.

Schoenfeld, L. S., 807, Majestic-building, Denver, Colorado, U.S.A.

Shamasastry, R., B.A., Government Oriental Library, Mysore, India.

Simkins, Arthur C., M.E., 807, Majestic-building, Denver, Colorado, U.S.A.

Tattersall, Alfred Rishworth, 75, Mark-lane, E.C.

Vernon, Arthur Longley, 10, Abbey-road, St. John's Wood, N.W.

Whiteley, Richard H., National State Bank Block, Boulder, Colorado, U.S.A.

Worsham, Ernest Lee, State Board of Entomology, Atlanta, Georgia, U.S.A.

The paper read was—

SOME NIGERIAN HEAD-HUNTERS.

By Captain A. J. N. Tremearne, B.A., D.Anth., F.R.G.S., F.R.A.I.

I.—Introduction.

One of my first experiences of the Kagoro was somewhat startling. I had been amongst them the previous month, and, as tribute had not come in as quickly as it ought to have done (some being more than two years overdue), I had given them a slight hint that there were other and stronger arguments on my side than mere words. The road from Jemaa is steep and very bad, and as I emerged from a path in thick bush into a clearing, there, in line with their bows at full stretch and arrows fitted, were some thirty men advancing towards me. I had no time to call the escort, who were some distance behind, and to have retired would have been fatal; so, feeling very nervous myself, I rode up and told them not to be afraid, my orderly calling out in Hausa, "It is peace." I found that they were out after small game only (mice and rats), so we were soon friends. In the old days, had a solitary trader met a hunting party, his skull would soon have decorated a hut, for although mice may furnish good sport, men provide much better.

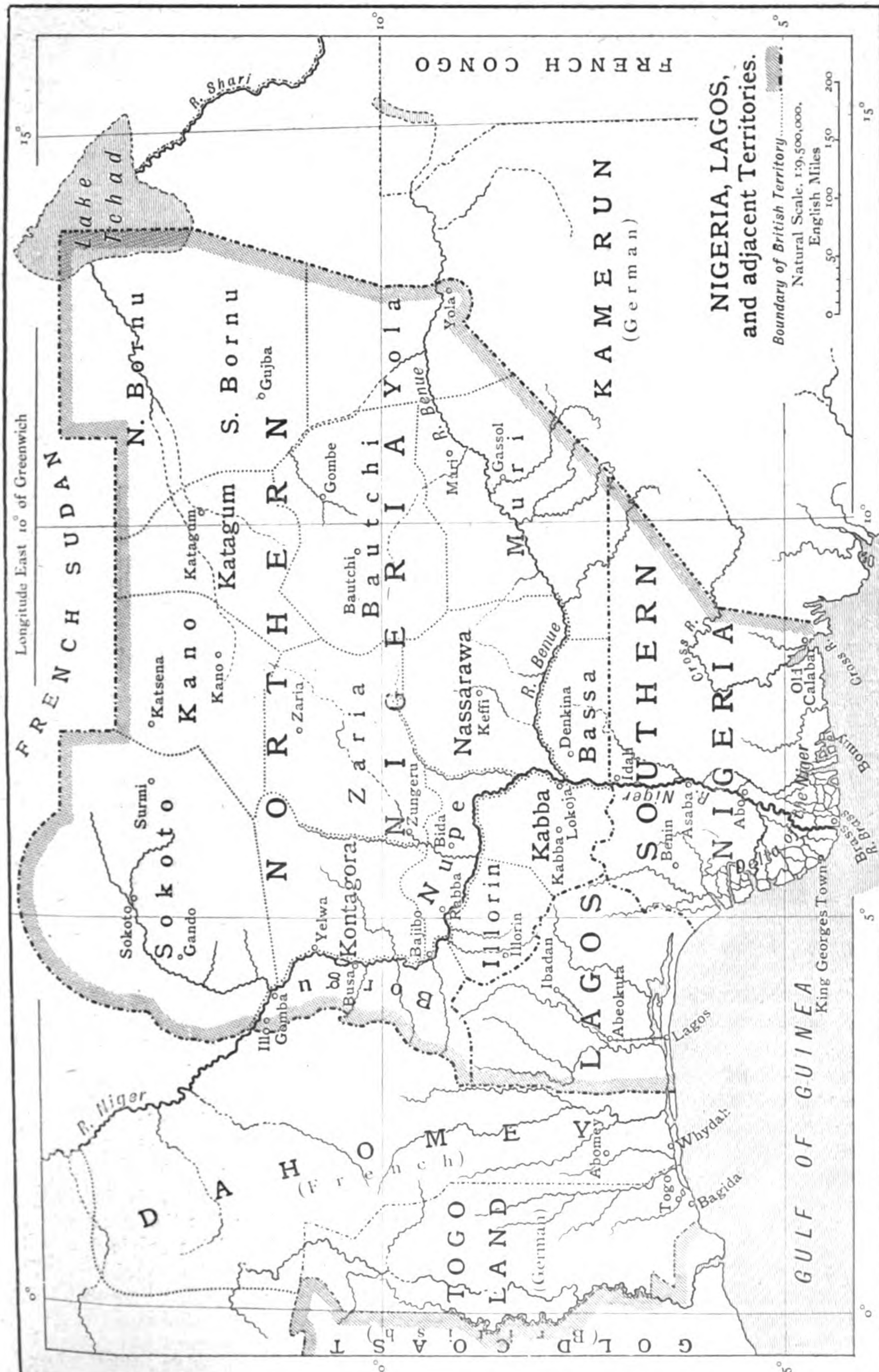
A political officer is usually one of the last persons to whom the natives in his district will confide their secrets, for (1) he has to see that they pay their tribute—and a tax-collector is not popular even in England; (2) he has to judge them by standards very often quite different from and even opposed to their own, so they tell him nothing lest he should see some wrong in their customs unsuspected by them; and (3) he has to put down many practices (head-hunting, for instance) which they look upon as necessary to their religion and well-being. Again, with many tribes (the Kagoro amongst them) any persons talking of religious beliefs may be stoned to death, so they are naturally very reticent, even though they regard a white man as a "big Juju" and as being connected with the supernatural. Savages, too, cannot keep their thoughts concentrated for any length of time, and after about half an hour one has to give up questioning them. Lastly, it is very seldom that a political officer can devote sufficient time to any single tribe in his district to know them properly. If he has the opportunity to find out their customs, he certainly will not have leisure enough to learn the language also, so he must depend upon more or less reliable interpreters. No man can be an encyclopædia.

These notes do not claim to be anything like a full description of the people with whom I was in touch for fourteen months, for in addition to the above reasons I should mention that a patrol had punished some of the tribes in June, 1908, just before I arrived at Jemaan Daroro; I accompanied one twelve months afterwards (August, 1909), and another went there early last year. It is therefore likely that a few statements may have to be modified when these tribes have been longer under observation, though in all sixteen authorities were examined with regard to the Kagoro, Moroa, Attakka, and Katab customs, and four with regard to those of the Kajji and Jaba, and no statement is made on the word of less than five of them, or else on the evidence of my own eyes. Luckily, nearly all spoke Hausa, so we could establish direct relations.

Measuring the heads was a delicate proceeding, as there was a chance that they might wish to keep a record of mine, and in a more substantial manner, so it was not until I was due for leave that I attempted it in their own towns. By that time the people had become accustomed to the idea, and, as each one received a present, and was told the book in which the entries were made was a magic one, I had not so much difficulty as was expected. I could, however, not get any women. I suggested it once at Tuku Tozo, and within half an hour the town was empty; this was after I had taken the photographs, though.

These notes refer to the Kagoro. The Moroa are so much like them that, except where pointed out, their customs, etc., may be taken to be similar. The Kajji also resemble their eastern neighbours. The other tribes are mentioned, here and there, only for the sake of contrast or comparison. I do not pretend to a knowledge of all of them.

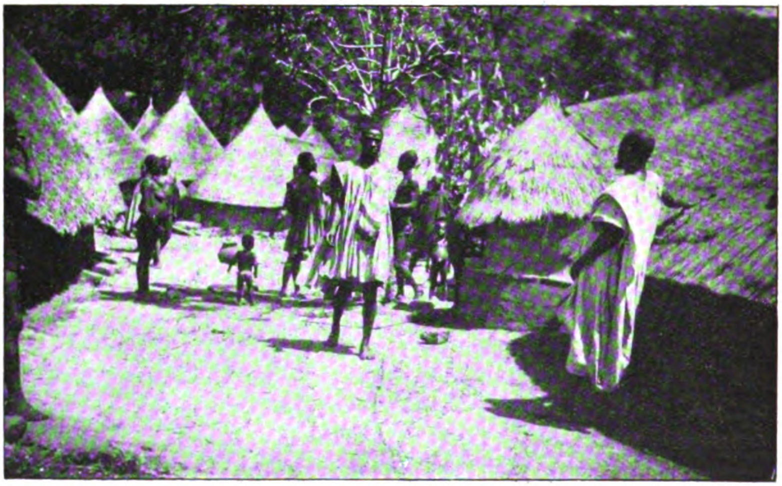
There is, however, one thing I think I may say of all, and that is, although they were



THE COUNTRY OF THE HEAD-HUNTERS LIES BETWEEN LAT. 8°-9° N. AND LONG. 8°-9° E.

sometimes shy, and always dirty, I soon became quite fond of them, and found them to be the same as most unspoilt peoples, viz., "but simple, overgrown children, playful . . . nearly always amusing, and often lovable." * Unfortunately for them, tin has been discovered near their country, and I fear that in a few years they will be as useless, from the anthropological point of view, as are the Sierra Leoneans of to-day.

The next slide will give you an idea of how some of the information was collected, though most of the religious part was learnt in private. This view is really one of a trial; not exactly as conducted at the Old Bailey, perhaps, but much better suited to the present wants of the country than an elaborate procedure would be.



A Kajji Village.

II.—Country—Origin—History of Kagoro, Moroa, and Jemaan Daroro.

Country.—The Kagoro, a naked, head-hunting West African tribe, occupy part of the north and west faces of a ridge of steep, high mountains running from the Bauchi into the Nassarawa province of Northern Nigeria. All but one † of the towns are built at the foot of the ridge, and nearly all on the north face are defended by labyrinths of euphorbia hedges, which sometimes reach a height of 12 to 15 feet. There are no stockades. In the slide can be seen the town of Kukkum, with the mountains behind. The total population is about 7,000, but this estimate is only approximate, for it has, up to now, been impossible to assess the people properly, as most of them run away on the appearance of a European.

Origin.—The Kagoro* say that they came long ago from Bauchi country westwards to Nimbia (Nassarawa), and from there they passed, after a short stay, to where Fada Kagoro now is. The leader of the party was Apak, after whom one of the towns is named. They there found the ruins of habitations of a former forgotten people—perhaps the makers of the stone axes discovered in the vicinity. The Kagoro themselves say that they have always regarded these as having been made by the splintering of rocks by lightning (this seems to be a general belief amongst the natives), and have never heard of their being used as tools, but the *Agwam* of Ogban recognised one shown him as an axe.

As the people have no records of any kind, the story of their origin is very hard to prove or disprove. One thing which supports their story—an important point too—is that in the towns on the northern face the sacred groves are all to the south, and the people first look in that direction when performing their mystic rites, the reason given being that they face

* "The Niger and the West Sudan."

† Lieutenant Matthews, R.A. (who relieved me as Political Officer), says he has heard that there are several villages on top of the hills, but that they have not yet been visited.

* Professor A. H. Keane mentions a tribe of Kagoro in "Man, Past and Present," but they are evidently not connected with these people.

their place of origin—while in those on the western face of the range the groves are to the north, and these towns, it is said, are colonies from Fada * Kagoro. As hardly anything is known of the languages of the Bauchi plateau no comparison can be made, but it is worth noting that the salutation is almost the same (*sham* or *sha*), though the tribes do not visit one another, and that all are head-hunters.

It is said that when the Kagoro first came to the country they now inhabit, they did not know the use of the bow and arrow, and this is possibly correct, for the Sa(r)rikin Jemaa told me that the Attakka learned their arrow poison from the Kibbo (Bauchi) only about twenty years ago, and that they taught the Kagoro; the Gannawarri use spears to-day. The place was so overrun with wild beasts, the legend goes, that they had to live underground and make tunnels to their farms. This makes one suspect that they were originally troglodytes, like the Nadu tribe to the south; they still have caves where they store their food, and which they use as hiding-places when attacked.

History.—It seems that for a long time they were ruled by councils of elders, and that it was not until the Kajurawa forced them to pay tribute that they chose a chief. There had been desultory fighting for many years without much result on either side, but about 120 years ago, so far as I can make out—possibly due in some degree to the wanderings of the Filani—the Kajurawa demanded a regular payment, and the Kagoro were not strong enough to resist. Two slaves had been asked for, so the Kagoro called a council to decide what should be done. A youth, Gundong, said he would supply the slaves if he were made chief (*agwam*), and this having been agreed to, he struck a silk-cotton tree (*ukum*) with his stick, and immediately two young slaves appeared, a male and a female, who were given as tribute. A simpler explanation occurs to one who knows their gentle habits, and that is that this was the beginning of the capture of passing strangers, which has been stopped only during the last three or four years. In fact the Kagoro say that before that time they were not head-hunters, nor had they any slaves.

Gundong was thus the first *agwam*. He is said to have reigned fifty years, and on the day of his death the cotton tree withered and died. His brother, Bishut, followed him, and lived for another forty years. There was an interregnum for some time when Jigya, or Jigga, played the part of a tyrant and at last had to run away and found a town of his own. The people then appealed to the Sa(r)rikin Jemaa to choose a chief, as they could not agree amongst themselves, and each town was fighting its neighbour. Bishut's son, Mungu, was appointed, but he died seven years afterwards, and was succeeded by Kaka, his brother, the present ruler (seen with his wives in the next slide), who was appointed District Headman by the Government in 1905. These chiefs were in no way subject to the Filani, although they asked the Sa(r)riki to choose them a chief. Jemaa, with Zaria's help, several times defeated the Kagoro, but also suffered some reverses, and never succeeded in subduing them, nor in making them pay tribute. The Kagoro people's first experience of a British expedition was in 1905, since when conflicts have taken place annually, and even yet three of the towns are not under control. I had to recommend two patrols during 1909. The first of these inflicted but little punishment, as there was hardly any resistance, and operations had to be suspended on account of the "rains." The second was opposed, and the medical hammocks were captured and held for some time as trophies of war. On this occasion three of the five Europeans, and many of the native soldiers and carriers, were badly stung by bees. After Gundong had given his slaves, the head of each family took it in turn to provide the annual contribution, and would seize even his own grandchildren. The towns have now been roughly assessed, and most of them have paid tribute to the Government direct.

There are councils consisting of all the heads of families; they form courts to try important cases, consult the oracles about war, etc., and practically control the chiefs.

The Attakka are now under control,* but it has so far been impossible to study them. They are head-hunters like the Kagoro, they dress in the same way, and their customs are said to be similar. They probably number about 7,000.

The Gannawarri have been patrolled, but they are not yet thoroughly subdued. They are nearly naked cannibals, the little attire they have being different from that of the Kagoro, as are also their customs. They were not in my district, and I was unable therefore to visit their towns, though I went a little way into their country to settle a quarrel.

* *Fada* = capital.

* A patrol visited the country in December 1909 and subdued them: they proved very poor warriors.

The Moroa say that their ancestors came from Zaria country to Kafanchan (north of Jemaan Daroro), and from there Enniluchwi and his wife went east and founded Ungual Tukunia.

The Katab are mostly in Zaria province, only one town being within the Nassarawa boundary, and I could not therefore study them. I was told that they originated in Kachicherri, north of Moroa. "There is a big rock, the Dutsin Kerrima," I was told, "where sorcery is practised; cattle were sacrificed there long ago. The demons* are very powerful, and earth is taken from the rock by the Filani, and mixed with potash for their cattle. Years ago Awudu, Sa(r)rikin Zaria, when subduing the Katab, gave the people a black bull to sacrifice, on the advice of his mallams.† Even now on Sunday and Friday nights the hill is luminous, and white cattle mount on top of the rock and walk about tended by a white Filani girl." I could not test the truth of this; the mountain may be a volcano.

The Kajji also resemble the Kagoro, but not so much as the Moroa. They are now thoroughly under control (as are the Moroa). They claim descent from the north-west, and this is borne out to some extent by Canon Robinson (in "Hausaland"). The late Lieutenant Boyd-Alexander visited the Kajji and Jaba country, but not, apparently, that of the Kagoro.

All these tribes are very good agriculturists, the Moroa being perhaps the best. They raise a great deal of guinea-corn and millet every year, but unfortunately make most of it into beer—or, as they call it, *akann*—so that from June to October they are usually in a state of semi-starvation, and have nothing but some bitter roots and what they can buy or steal. It is —as far as these peoples are concerned—a pity that the importation of liquor is prohibited, for they will drink, whatever we do, and if able to obtain gin (which would apparently be much less harmful than *akann*‡) they might keep their grain for food, and would then have less temptation to loot their neighbours' supplies, and so be more inclined for peace.

History of Jemaan Daroro.—Jemaan Daroro has conquered most of the surrounding country but could not subdue the Kagoro nor the Attakka. The following account was given me by the chief (Sa(r)riki), who is shown in the next slide, with the judge (Alcali), the chief's eldest son (Mada(i)ki), and others.

A mallam of Kebbi, named Usuman, having obtained leave from (Sheik) Othman to preach the Koran in Zaria, came about 100 years ago to Kachicherri and taught among the Filani there. Those people were at that time living in *rugas** with their herds, but they had villages where their slaves (*rundawa*) were allowed to live and farm on reaching maturity.

On the outbreak of the *Jehad* the Filani all ran away and came to a town near the mountain of Daroro† overlooking the present Jemaa. About a year afterwards Mallam Usuman and Abdurahmanu, their chief, camped on a hill N.N.E. of the present Sa(r)riki's house, and close to the river Jampallam, the people gradually spreading over the ground now occupied by the town.

It seems that the Sa(r)rikin‡ Kajurawa, in whose country they were, had called all his chiefs together on hearing that Zaria had been taken by Mallam Musa, and had decided to wipe out the whole Filani community, as they feared that if they left them, they themselves would be conquered later.

Now, the Sa(r)riki had a Filani girl, Indema, as a concubine, and, being very fond of her, he foolishly told her of the plot the evening before it was to have been carried into effect. Naturally Indema soon afterwards said she felt very ill, and that she would have to get some medicine from a man at Ungwal Tagamma—where the Filani were. The Sa(r)riki offered to send a slave, but she said she must go herself—love must have been very blind in this case—so he gave her a cone of salt § as a present for the "doctor," and sent her off with some slaves as an escort.

On reaching a stream near Ungwal Tagamma, she bade her attendants wait while she bought some butter, and, going on alone, she went to Abdurahmanu the Chief of the Filani there, and told him. Indema having left again, he at once called his people together, and they all got away in the night; so next morning when the Kajurawa came to kill them they found only the very old and very young cattle which were unable to travel, and had been abandoned.

* This account was given me in Hausa, the word used was Aljen, not Kurua—a spirit, shadow.

† Mohammedan priests or learned men, also magicians.

‡ Report of the Committee of Inquiry into the Liquor Trade in Southern Nigeria. Sir Harry H. Johnston ("Liberia," p. 988) also says:—"The use of this much-decried form of alcohol [trade gin] in the interior of Liberia, as in other parts of West Africa, seems to be much more medicinal than anything else."

* Filani temporary shelters.

† Daroro probably means "high," from the word "to look around."

‡ Sa(r)riki=chief; sa(r)rikin=chief of; *a* as in sat.

§ Salt is in this district a form of currency.

They followed the Filani as far as the river (between Mada(i)kia and Kafanchan), and killed a few, but they were driven off with the loss of thirty-three horses, and the main body of the Filani escaped. Indema did not flee but returned to the Sa(r)riki, who was so furious that he had her thrown alive into a hole and stoned to death.

The Filani on coming south drove out the Daroro people towards the town of Nindam, the only one now possessed by the tribe. The Kagoro at that time were quite friendly, for the Filani had not commenced slave-raiding. About four years afterwards Mallam Usuman was sent to Mallam Musa (then Sa(r)rikin Zaria) to obtain a flag and a name for the new settlement, that being the procedure for the official recognition of a town, and when Mallam Musa asked where had they come from, Usuman answered that the party (*jemaa*) had settled close to the mountain of Daroro. "Very well," said Mallam Musa, "the name of your town will be Jemaan Daroro," and he then gave Usuman a flag, a robe, a turban and a fez to be bestowed in his name upon the man whom the Filani should choose as their chief.

While at Kachicherri, levies of cattle had been made by the Kajurawa on special occasions, *e.g.*, if the chief's wife gave birth to a child 100 cattle were demanded, if the chief's son's wife had a child twelve head, and any of the sa(r)rakuna* on similar occasions took ten, but no regular tribute had been paid. On arrival at Jemaa these presents were discontinued.

For some years the Kajurawa were continually attacking Jemaa, and at first it was all the Filani could do to keep them in check; in fact, on one occasion, the pagans actually rode through the town, only to be driven out again. However, after a great fight lasting seven days, the Kajurawa were at length defeated and pursued, those who escaped returning to Zaria, only to be conquered later on by Mallam Musa.

It seems to have been about 1810 (probably two years after the Kajurawa were scattered) that Mallam Usuman paid his visit to Zaria. On his return the election lay between himself and Abdurahmanu, and he was chosen, the latter chief installing him. Mallam Usuman then returned to Zaria with the news, and was taken by Mallam Musa to Sokoto† to be officially recognised. He reigned until 1833, when, feeling too old to continue, he took his son Abdulahi to Zaria to have him appointed in his stead, and Usuman died the following year. During his reign Ayu had been conquered, and most of Numuna, Karshe, Moroa and Kajji.* Some Ayu people are shown in slide 7. Lander is said to have visited the town about 1827. He is supposed to have come from the north or north-west and to have wished to go to Bauchi, but as the road at that time was impassable he had to return.

* Petty chiefs, princes, etc.

† Sokkotu would represent the sound much better, and would apparently be quite as correct, but the above is the official spelling.

Abdulahi I. (1833–1837) was the eldest son of Mallam Usuman. He went with the Sa(r)rikin Zozo (Zaria) to Lafia Beriberi to help the chief of that town against some of the surrounding tribes. During his absence the Kagoro attacked some people at Mongwe—a suburb of Jemaa—and killed forty-two. Abdulahi then returned, and Jigya and Tafa were destroyed, the Kagoro losing thirty-one. He then went back to Lafia, and was soon afterwards shot in the neck with an arrow and killed when attacking Kwachigiddi.

Musa (1837–1842 and 1847–1850), Mallam Usuman's second son, then became chief, being appointed by Abd-el-Karimi of Zaria. He was a drunkard, and Hamada, the new suzerain, threatened to depose him, calling him and Abdurahmanu to Zaria, but dying before he could carry out his intention. The new Sa(r)rikin Zaria (Mahamma Sani) did so later, and appointed the old chief Abdurahmanu, banishing Musa from Jemaa territory.

Abdurahmanu (1843–1847) was now very old, and after three years was deposed through the machinations of Musa, who was again appointed, only to be again removed. Musa seems to have been a great warrior, for, in conjunction with Abd-el-Karimi, Ninzam, Kagoma, and the rest of Numuna were conquered, and the Kagoro were defeated and most of their crops destroyed in a war lasting some months. They would have been annihilated had it not been that a mallam had a dream and prophesied that whoever finally conquered them would die within a year. The war had then lasted some twelve months, and on that Sa(r)riki Abd-el-Karimi retired, as he could get no supplies—the Kagoro having buried all their remaining grain—and the war was abandoned. The Kagoro had been brought to such straits that they afterwards came to Jemaa to beg for food, and 100 of them were taken to Zaria as slaves. A similar thing happened when Sa(r)riki Awudu of Zaria

* Districts of surrounding tribes.

and Adamu of Jemaa fought them. The prophecy is supposed to be still in force. The Kagoro were thus never properly conquered by the Filani, and they never paid tribute to Jemaa, though the Kajurawa had taken slaves from them annually.*

Adamu (1850–1869 and 1881–1885), a full brother of Abdulahi, succeeded Musa. Except for Abdurahmanu, the two branches of Mallam Usuman's family seem to have furnished chiefs alternately, each taking it in turn, with Zaria's sanction, to eject the other. The usual charge seems to have been drunkenness, though there is no doubt that the claimant who brought the best presents to the suzerain was always the most successful, and, theoretically, the most temperate.

Mamma Adda (1869–1881 and 1885–1888), son of Mallam Usuman, also had two tastes of power, being finally replaced by the present chief.

Abdulahi II. (or Matchu) began to reign in 1888. He is the son of Abdurahmanu, son of Mallam Usuman, and was appointed by Sa(r)riki Yerro of Zaria, while fighting in the Kagoma district. Abdulahi has seen a good deal of service, having been wounded eight times altogether.

There had been wars with Keffi in the time of Adamu, but the fighting had been stopped by the Emir of Sokoto. However, about 1893 trouble arose with the late Magajin Keffi (Maloney's murderer) over land near Tsaunin Kolere, some of which was still in dispute in 1909. The Keffi people came in 1895 as far as Numbu while the Sa(r)rikin Jemaa was at Zambar, but the latter drove them out, and appealed to Sa(r)riki Yerro of Zaria, who decided in favour of Jemaa as regards the Numuna and Ninzam portion.

About four years later a plot was formed to replace Abdulahi by his brother Usuman, the ex-Sa(r)rikin Jagindi—a town founded on a deserted pagan site by the Filani in the reign of Adamu — the chief conspirators besides Usuman being Umoru Sa(r)rikin Delle, and Shemaa, a Filani. Another was Mallam Momo Tsula, since made (in-)famous by his work at Abuja last year where he tried to seduce soldiers and raise a revolt, but was captured and imprisoned. Usuman had been deposed by his brother and had gone to Keffi, but returned to plot, his supplanter bringing the news to Sa(r)riki Abdulahi at Jemaa, who persuaded a man, Dan Zabia, to go to Umoru's house at night and murder him. The death of the Sa(r)rikin Delle so enraged his followers that the whole of the Jagindi people at once rose, and were soon aided by the Kagoma and Kajji tribes, and by Dangoma. Fighting went on until 1903, when the Resident of Keffi intervened, and a year afterwards Usuman and Shemaa were deported.

No resistance was offered to the Europeans by Jemaa himself, but there has been trouble with every one of the native tribes surrounding. The Yeskwa, previously conquered, killed seventy-three out of a Jemaa force of 377 sent against them in 1900, and have since thrown off their allegiance, while the Ninzam have always been restless. I once had to hang a Ninzam chief for murder, and his brother sent a message to say that he would have my head to decorate his hut as compensation. We visited the town soon afterwards, but the people seemed to have "a previous engagement." The man sent in his submission, and on coming to me I made him chief instead of his brother. That, no doubt, seems a strange procedure to English ears, but one is only too glad to have a strong man in office if he has once acknowledged his defeat. Another Ninzam chief, when called upon for tribute, said he wanted to have a little fight first. He was, of course, obliged, and after about half an hour he sent a message to the effect that his people thought that they had the worst of the argument, and that tribute was forthcoming. Abdulahi is a strong man and requires firm handling; he naturally does not appreciate our control. He can hardly speak Filani, his children not at all, and they are turning into Hausas. All tribes which Jemaa conquered pay their tribute through him as suzerain; those still independent on our arrival, and since subdued by us, pay direct to the Government.

Owing to the fact that this country once belonged to the Kajurawa—the principal representatives of which tribe are now at Sanga—the courtesy title of the Chief of Jemaa is Sa(r)rikin Kajuru Filatihu.

Chiefs of Jemaan Daroro.

0. Abdurahmanu, principal chief at Ungwal Tagamma, came to Jemaan Daroro, but not recognised as Sa(r)riki until 1843.

1. Mallam Usuman, 1810–1833, first chief appointed by Zaria.

2. Abdulahi I., 1833–1837, killed in action.

3. Musa (first time), 1837–1843, deposed.

* The Kagoro are now thoroughly under control, and the prophecy has been disproved, for it is more than a year since their final defeat.

4. Abdurahmanu, 1843–1847, deposed.
5. Musa (second), 1847–1850, deposed.
6. Adamu (first), 1850–1869, deposed.
7. Mamma Adda (first), 1869–1881, deposed.
8. Adamu (second), 1881–1885, deposed.
9. Mamma Adda (second), 1885–1888, deposed.
10. Abdulahi II., 1888, still reigning.

III.—Scarification—Painting—Ornaments—Deformations—Clothing—Abnormalities—Invention.

Scarification.—All members of the Kagoro, Kajji, and Moroa tribes are scarified, and I am told the same holds good with the Attakka and Katab. Before the present pattern was adopted, each tribe had irregular cuts on the forehead only. There seems to be no religious significance, the lines being simply to denote race, and this must be correct if what they say about copying those of the Katab is true.

Males and females have the same marks on the head. These consist of numerous short perpendicular cuts right along the forehead from ear to ear, and long slanting lines (thirteen or more) on each cheek from ear to chin. In some cases (particularly amongst the younger men) a sort of zig-zag is added to the lowest line, but this is not compulsory; the other marks are, except in Tuku and Tuku Tozo, the people of which towns seem to be separating themselves from their northern relatives, and desirous of settling down peacefully under Jemaa. There are no euphorbia hedges there, and the "tails" of the women are of a special shape. Men may have in addition patterns on the chest, composed of rows of cuts about ½ in. to ⅓ in. in length and usually made slantwise, but they are voluntary and seem to be dying out. They are not confined to persons of rank.

These marks, I was told, are merely for the sake of ornament. They are not regarded as charms in any way. I could not find out what the patterns are intended to represent. The people said they did not know, and, if borrowed, this is probably quite true. Youths have the forehead scarified when able to hoe. The only raised scars I saw were on a Kajji man at Mersa, and this seems to have been an accident.

There is no doubt that Hausa patterns will spread, and be adopted even by the Kagoro, especially those which are supposed to have particular virtues—prevention of sickness, retention of wife's fidelity, etc.; many of the Kajji already have them.

Women's chests and backs are decorated with a regular pattern, so there is no need for them to undergo fresh pain for the sake of acquiring additional beauty. The first to be done are those lower down, and these seem to vary a little in design. When a girl reaches the marriageable age, the chest and back will be scarified, and when she goes to her husband the forehead. The rows of marks (made as in the men's chest patterns) may be increased in number, and the pattern on the abdomen may change. There is no danger of a Kagoro girl losing her "marriage lines!"

The scarifier is an important person, though he has not the exclusive right to operate on everyone, and the office is practically hereditary, for no man would teach a youth other than his own son or nephew.

Painting.—At feasts (marriages, etc.) both sexes paint a black stripe about one inch wide from forehead to stomach, and sometimes there may be a narrow line on each side, or each of these lines may be divided into three. No colours are used but black pigment and the red earth mentioned below, and no other designs are permitted. They are, of course, in addition to the scarification. The pigment is obtained from the unripe kernel of a certain thorn-tree (Kagoro, *illak;* Hausa, *gaude*), which is pounded up, mixed with water, and applied with the crushed end of a stalk of guinea-corn. For scarification (which is to be permanent) the incisions are painted with soot from the bottoms of the cooking pots, mixed with grease. The black and red are easily obtainable; so is white earth, but it is not used on the bodies, though it may be eaten in certain cases. There are no special artists for the painting, the people do it to each other, but for scarification a particular man is resorted to if one wants it well done.

The women usually smear their bodies with red earth (mixed with grease if they can get it), and the men, at certain times (*e.g.*, dances), may coat their legs up to the knees. This is said to be merely for the sake of ornament; it may also keep off insects. No distinctive dress is worn for prowess in war, though a male was not supposed to have attained to the dignity of full manhood until he had killed someone. There is a general idea amongst Jemaa people that he was not allowed to marry until this desirable feat had been performed, but the Kagoro deny this, and, judging by the early age at which youths obtain their brides, I feel inclined to believe them. On the return of

the hero to his house, his whole body was smeared with red earth, and he was carried in procession on the back of a friend, the women of the quarter meanwhile dancing and waving their hands before them, and singing his praises.*

It is rather surprising that they have not learned to put antimony (or sulphide of lead) on their eyelids, nor to stain their nails and hands with henna, as do the Filani and Hausas near them. They say they are afraid to ornament their hands lest it should interfere with their farming, and it is quite possible that this idea is fostered by the men so that the women will continue doing the hard work.

Ornaments.—No special badges of rank are worn—not even in war. The chiefs do not themselves fight, for a general is chosen by the people before the war commences. They, however, follow their men to drive them on if necessary. Youths may dress their hair; girls and women shave their heads. With Kagoro, some males up to about the age of twenty allow the hair to grow in a broad tuft from the forehead to the back of the neck, reminding one of children's wooden horses in England. Some Kajji say that a youth should not shave his head until he has two children, but this is doubtful. Some plait the hair instead and ornament it with beads, as do the Kajji, or arrange it in the shape of a mop. Young girls may do likewise, but shave the head when about six years of age, possibly because they have to carry weights (wood, water, grain, etc.), while the men very seldom do so. The older men usually allow the beard to grow, but the moustache may be shaved now and then. No shaving seems to be done while preparing for the harvest. I could not ascertain that there was any reason for this, except that the men were too busy on the farms, but I suppose there is one.

Deformations.—Both lips of the women are pierced for the reception of pieces of wood called *tichiaks*. These may be over 1 inch in diameter and about ¾ inch high. Sometimes the outer face is ornamented with beads, tin, or coloured earth. They are easily removable, but are supposed to prevent females eating fowls or dogs, the latter a very great privation. These people do not kiss each other, so there is no objection to the *tichiaks* on that score. The lips are usually pierced when the girl is about seven or eight, stalks of grass being worn at first, and then sticks of increasing thickness, until the *tichiak* itself can be inserted. These are of varying diameters, and when very large make the lips project so much that, seen sideways, the wearer has a pig-like appearance.

Both ears are pierced in the women, only the left in the men, and they are treated in the same way as the lips. In the southern towns the piercing of ears in males is not compulsory. Beads, usually in the shape of blue glass rings, are bought from Hausa and other traders, and worn; or if these be unobtainable, string or sticks will do, never metal. There seems to be no way of mending torn lobes, for I have seen several in spite of the fact that ear-rings are so light. The nose is not pierced, as with the cannibal Nadu to the south (*septum*), and the Beriberi of Bornu (right nostril), nor flattened. Teeth are not filed nor broken.

The heads of infants are massaged backwards to keep them from becoming too broad; both sexes are treated in the same way, the mothers (who do it) first warming their hands and using grease. The mode of carrying children does not influence the shape of their heads much. The women may bind themselves tightly after childbirth to avoid becoming permanently fat, but there seems to be no permanent constriction, and there is no artificial elongation of the mamma. There is no deformation of the feet or fingers.

Clothing.—The chiefs who have been recognised by the Government wear Hausa robes, and are called *agwams*. No other Kagoro wears any cotton of any kind, but Kajji and, to a less extent, Moroa men buy clothes from the Hausas if they can afford them. The males wear a leather triangular loin covering after they have reached the age of six or eight, possibly earlier if the father happens to have skins to spare; Moroa and Kajji men may wear cotton loin-cloths. Some wear another skin over the shoulder as a cape, the two front legs being tied together to serve as a cord, and enabling it to be shifted to the side exposed to the wind or rain. Both garments are made of goat or sheep skin, the hair being left on the

* Compare Dr. Haddon's remarks in "Head-hunters, Black, White, and Brown," page 394:—"There can be no doubt that one of the chief incentives to procure heads was to please the women. Among some tribes it was said to be an indispensable necessity for a young man to procure a skull before he could marry, and the possession of a head decapitated by himself seemed to be a fairly general method employed by a young man to ingratiate himself with the maiden of his choice. The fact of a young man being sufficiently brave and energetic to go head-hunting would promise well for his ability to protect a wife . . . The pride women feel in their men-folk who have taken heads is not confined to these people of Borneo; formerly amongst the western tribes of Torres States a young man who had taken a skull would very on receive a proposal of marriage from some eligible young woman."

latter, but not on that for the loins, which is tanned. There is no special "tailor," the skins are prepared by the wearers themselves.

Girls from three to four until married wear the *ivyan*, a girdle of loose native string—not plaited nor twisted—which is tied around, but lower than, the waist, a long end meeting the girdle again near the small of the back. This is an absolute sign of virginity. Married women wear a tail (*kunnok*) instead of the girdle, which is in shape something like a mushroom; some are long and thin, others are short and stumpy. The tail is made of a palm fibre very tightly drawn together and bound with string, the wide wheel-shaped part being plaited like basket work, and they may be left thus, or may be coloured red with earth to match the wearer's body; two strings of the same material attaching the tail to the waist. The next step in ornamentation is a row or two of beads around the edge, and then brass wire may be bound around the body of the *kunnok*, or it may be covered with sheet brass; finally, the under part may be decorated with beads in a regular pattern. The brass, is of course obtained from the Hausas. The beads (from them or other traders) are strung on thread, and then stuck on with liquid rubber, of which there is plenty in the country: they are not sewn in any way. The fancy patterns were, I think, invented by the Jaba, a tribe to the west of the Kajji; they are extremely rare amongst Kagoro women.

I was told that sometimes a bell is worn above the tail, but I do not know under what circumstances. The Tuku Tozo tails resemble a bell.

When a girl has been married her mother takes off the girdle, and a small branch or bunch of leaves is hung to a string in front. Many women—especially when old apparently—wear leaves both before and behind, though this is not compulsory, but those in front are a sign of marriage. At certain times (dances) leaves may be worn by young girls; this, perhaps, corresponding in some degree to our young people taking grown-up characters at fancy-dress balls. Tails and loin-coverings are not sacred to the owner, and if in good condition at the time of the wearer's death may be passed on to other members of the family. These peculiar articles are probably responsible for the old belief in tailed people in Nigeria.

No Kagoro, Kajji, Attakka, or Moroa woman would dare to attire herself in any other than the prescribed fashion, though the only punishment which would be inflicted is, apparently, the disapproval of her own people. The differences in the adornment and shape of the tail seem to be the only variations sanctioned. I have known girls, taken away when young, and dressed in Hausa cloths, at once to discard these for the *tichiak* and *kunnok* on their return. On the other hand, the mutilation of the lips is not at all popular amongst women of other tribes. Having to judge once between a husband who wanted his wife (a runaway slave from Sokoto) *Kajji-ised*, and the wife herself who thought her natural charms sufficient, I decided that she must adopt the leaves and tail as she was married, but that her lips were not to be touched, for the perforations should be made when the girls are young. They seemed to be satisfied; I am sure I was.

No head-covering is worn by either sex, but a cape—something like the sack with one side cut open worn by coal-heavers—is made of palm-leaves for protection against the rain. This may have been copied from those made by Hausas, their name for it (*kabiddo*) is often used. A sort of immense three-cornered grass hat is worn by Ninzams. There are no coverings for the hands or feet.

The Gannawarri women wear a number of iron rings in front and a kind of leather brush behind, but no leaves nor tail.

I have some figures concerning the height and other measurements, but I think we need not trouble about them to-night, and simply pass on to—

Abnormalities, etc.—There are no albinos nor persons with red hair, nor, apparently, any with an excessive amount of hair, or with none at all. Old people are looked after by their children—especially the fathers—but their death is nothing to be sad about, in fact quite the opposite, for the older and more important the deceased the greater the wake. They are, however, never killed.

If a child be an idiot or unable to move about it may be thrown into the water, "but not killed," so they say, though it comes to the same thing apparently. This usually happens when the child is between the ages of one and four, but in some cases he may be given a much longer time in the hope that he will recover. "It is evidently a snake and not a human being" (so I was told). "If, after you have thrown him into the water you go away, and then come back silently and hide yourself, you will see the child lengthen out into a snake." This was done at Jemaa, and in the surrounding districts

also. Matchu (blacksmith) says that his grandfather (Shobin) took a boy to the riverside and made him sit with his face to the stream. He and the boy's father gave the boy some *kunu*,* and while he was eating it they stole away and climbed a tree overlooking the river. Soon the boy glanced around, and, seeing no one, began to grow until he was as tall as a tree, turning at the same time into a snake. Shobin and the father were terrified and ran away, the former tearing his leg during the flight, the mark, which he had to his death, being, of course, an indisputable proof of the truth of the story. It is probable that once, on some former occasion when a child was thrown in, a crocodile or some other monster leapt up and caught him, thus terrifying the onlookers, and giving rise to this myth.

If a Moroa gives birth to an idiotic or deformed baby medicines are tried, even up to the age of ten years if necessary. The mother will nurse it for some time, and if it does not become normal may leave it with the father and marry someone else. When the father is convinced that it is useless to expect any improvement he calls in a Kagoro or Attakka priest, who will throw it into the river Kaduna. He himself has to hide, for the child turns into a pillar of fire and smoke,† and would consume him if present. The mother will never return to the house while the child is alive lest it prevent her having normal issue, but she may come back after its death. The Kagoro and Attakka have much stronger "medicine" than the Moroa, so they do the drowning themselves. It is just possible, judging from this and from the fact that the Moroa's time of probation is so long, that the Kagoro taught them the custom.

Invention.—The people are not very inquisitive nor anxious to learn new ideas, tools, etc., from their neighbours; they seem to be quite content to remain as they are, and simply say, "We Kagoros do not do so," or "Our fathers did not teach us." Thus even now, none of them (nor of the Moroa and others) can forge iron or make their agricultural implements, although foreign — generally Hausa — blacksmiths have been with them for many years. And they will not wear clothes, in spite of the fact that during the harmattan season their climate is very cold. They are, however, learning the Hausa language, but not that of the Filani, for the latter—having been slave-raiders—are their natural enemies.

They are courageous, and have made tribes much bigger than their own respect them. None have as yet been educated, so it is impossible to say whether they would readily return to their native state if once removed from their surroundings; but I should say that they would, judging from the way in which they cling to their attire. They have such a strong love of freedom and conservatism, that I do not think they would relinquish their liberty, nor take to any European customs without compulsion, and as that would be contrary to our principles we let them alone so long as they keep their roads open, and remain peaceful. The tax imposed is merely to remind them that they are no longer able to indulge their little hobby of collecting the skulls of their neighbours without bringing upon themselves the serious attention of a stronger power. The incidence is about one penny per head per annum; such a tax would be welcome here!

IV.—Habitations—Building—Decoration, etc.—Reoccupation.

Habitations.—Houses are built of red or black mud, and have grass roofs. The walls are 3 ft. to 4 ft. in height, and the roof is higher at the back of the house than at the front. Each house has one central door, or in a few cases two, opening into the compound, and each wife has a separate house for herself and her family. There is a porch or hall, extending along the whole width of the house, where wood is kept, and a verandah outside that, where the people sit in wet weather during the day, or outside in dry weather on palm-tree logs let into the ground. The porch has a doorway about 2½ ft. to 3 ft. high in the shape of a half-hoop. Between this and the sleeping apartment there is another doorway, closed by a sliding mat let into the wall. The outside doorway may also have a sliding door, or perhaps a curtain of string.

The arrangement reminds one somewhat of a Canadian railway sleeping-car, the verandah resembling the open-air space for observation, the porch, the smoking-room (where the fire is). Inside that are two compartments opposite one another, which can be compared to two sleeping-berths; in fact they are used as such, that on one side (I believe always the right) has a bed of palm-fronds or bamboos raised about one foot from the floor, and is for the husband

* Native broth.

† An English legend of a person changing into a ball of fire on plunging into water is mentioned in "The Science of Fairy Tales."

and wife, that opposite being for the rest of the family. Then, further on, is a circular room, in the centre of which is a large earthenware vessel for holding grain, built on stones, and there may be other smaller ones also.

The dome of the roof is over the granary, which is in the shape of an enormous vase (opening at the top), thus giving room for persons to climb into the attic and take the grain, or to hide if necessary, and also—so they say—to keep the smoke away from the rest of the house. There is no chimney of any kind, but it naturally goes to the highest part and escapes through the thatch. The smoke is probably also useful in keeping the grain free of insects to a slight extent. A man may have a compound to himself, or he may allow all his sons and their families to live there also, thus forming a miniature village. The houses are built on the ground level, none are on piles, but boys watching the crops have a scaffolding so that they can see over the grain.

Building.—I am told that anyone is free to build or farm where he likes on unoccupied land, provided that the spirits agree. The father chooses the site of the son's house, and places stones in circles, or threes, for the granaries to rest upon. The blood of a fowl is spilt as an offering to the people already buried there, or near, so that they may leave the house in peace, then a few leaves of the *Nok* tree are put in a hole in the spot chosen and covered over. This is supposed to bring good luck to the house. After that, the prospective owner invites all the "big men" to inspect it, and of course provides beer (*akann*), without which nothing is done. A little beer is poured three times on the place after three incantations, and an ancestor's aid is invoked, the rest being served out to the company. When they have drunk all they can get, they tell the man to remain in peace, and he starts building. When the house is completed, *tuk* (evening meal) is prepared (on this occasion I am told no beer is drunk—but I can hardly believe it), the people of the quarter are invited to share in the feast, and when all have eaten and departed the family enters.

No sacrifices are made when building (except for the fowl killed as above) or when felling trees, nor are any charms, tokens or coins put in the foundations, as with us. While on the subject I may mention that in Angwom (Ninzam) I saw a rooster which had been put into a pot let into a hole in the step of the outer porch, and as the neck of the pot was narrow, only his head could protrude. Fowls are often kept in pots for fattening purposes, but in this position the rooster acted as a watchdog as well, for no one could pass into the house without disturbing him. A man is free to farm on unoccupied ground, but he must obtain the consent of the spirits (which really means that of the elders) as above; the *meakwap* will sometimes cut the first sod, and beer is offered.

A fowl is killed when the corn is ripening, a hole is dug in the centre of the farm, and the blood of a fowl and leaves of the *narrankwoi* and *tongwai* are put in it. When the corn is ready for harvesting, fires are lighted of *kungut*, and the smoke enters everywhere and kills the insects. After the corn has been stored in the granary another fowl is killed, and the blood is smeared on the outside, the flesh being eaten by the men. Young women must not eat fowl "as their lips are pierced"—the old ones may, apparently. The blood has the same effect as the beer; it appeases the appetites of the ghosts, who will then allow the people to live in peace—until, of course, they are thirsty again.

The roofs are made of bamboos or palm-fronds in the shape of a dome. They are not regular though, for the poles from the top to the front of the house are much longer than those to the back, the apex being over the granary. The poles are lashed together with tie-tie, and look like a spider's web, as the lashings are in concentric circles. The grass stalks—about 5 ft. to 6 ft. long—are then joined together into a flat layer with tie-tie and rolled on to the poles, beginning at the bottom of the front and going first from side to side, and then round and round the house until the top is reached, where the knob is tied and may have two sticks thrust through horizontally, and a large egg or bottle on the top as a charm. Each roll of grass is tied to the cross-lashings and joined to the next roll.

When building the house the granary is first made—so that it may get the sun, and because it will take longer than the walls, being higher—and then the rest of the house.

The floors are trampled until hard, and sometimes charcoal is mixed with the earth (as also with the walls) to blacken it. Cowries are often inserted as ornaments, and arranged in circles or "dice-cup" patterns. Sometimes even the whole compound has a beaten floor.

Decoration.—The outer front wall of the house is usually decorated, even if the ornamen-

tation goes no further than a coat of red earth, and in some towns designs are worked out, as has been seen, the Kajji houses usually being far ahead of those of the Kagoro and Moroa people.

Sometimes the doorway itself is also ornamented by lines running around the space. All the lines are made by pressing sticks (straight or bent as required) into the soft mud when the house is being built. The dice-cup pattern is used on the body also.

The porch generally has a long trough-like shelf of mud running over the inner door (= the hat-rack), and the inner rooms also may be furnished thus; this is to place the calabashes in. Sticks or horns may be stuck in the wall to hang bow and arrows, etc., on, and I have also seen a hanging hook of wood something like a swizzle-stick, or an umbrella-frame upside down, it having been simply cut from the fork of a small tree, and not improved in any way.

Low wooden stools are used in the houses. Skulls of men, also those of the hartebeeste, antelope and monkey, are strung on a piece of native rope and hung up on the outside walls under the thatch to advertise the family's prowess,* and these are passed on as family trophies. There are some medicine-houses (although this is denied), but I can get no information about them from the Kagoro, and no alien is allowed to go near. A cave containing a large number of skulls was found by the first expedition. The Moroa have a house at Béniki, I believe, and it is said that there are others.

There is very little refuse. The ashes are put in the goat-house and are used as manure. the remains of the night's food are usually eaten next morning or given to the dogs or vultures, while any loose grain is soon picked up by the fowls and goats. Pits are, however, necessarily made when the house walls are being built, and whatever refuse there may be undisposed of is thrown in. The Kajji compounds are kept very clean, but the Moroa and Kagoro housewives are not so praiseworthy, and, as the people are not very careful, the air is not always so pure as it might be.

Reoccupation.—A house is reoccupied on the death of the owner, although he may be buried in the porch itself. If the owner has children—and this seems to include the occupier of the house (a wife) as well as the possessor of the whole compound (the husband)—he or she is always buried close to the porch; if he has none, he is buried outside close to the walls so that the roof will protect the grave. A compound has a house for each wife, outside granaries, goat houses, others for the preparation of food, and stables, etc. As stated before, the Kagoro towns with the exception of the five in the south, are all built at the base of the mountain spur, so as to give a retreat in the event of an attack. Caves up above are filled with grain, and in case of alarm are inhabited. The compounds are surrounded by euphorbia, the juice of which, it is stated, will blind anyone if it gets into his eyes—goat's milk is said to be the only remedy, and it must be applied at once—and if the people retire they let loose swarms of bees (*shoi*) which are even more effective than their arrows for repelling assaults.*

V. — Basket-Work — Pottery — Metallurgy — Machinery — Fire — Natural Forms — Writing — Weaving — Agriculture — Trade.

Basket-work.—The commonest form of basket in the northern towns is the *Uncharra*, for carrying millet, etc. This is in the shape of a calabash and the weaving is of the simplest form. The Tuku people make a basket with a handle, and there is another kind used for carrying water or honey, which is, I understand, made waterproof by being daubed with mud, but I was unable to procure specimens. It is not used as armour. Goat skins form bags for grain, but most are made of straw.

Pottery.—Baskets are not employed as moulds for pottery, for none is made, except in Kaderko and Duchui perhaps; all pots are procured from the Attakkas. There is no wheel. One method is to mould the fresh clay on to an old pot, as with Hausas and others. It is possible that the want of suitable earth was the original reason—though to all appearances the Attakka country is exactly the same as that of their neighbours—but there is certainly a prohibition against it now, for Attakka women who have married Kagoro men are not allowed to make pots at home, but must go to their own country.

* This custom is apparently common, for Dr. Haddon states ("Head-hunters, Black, White and Brown," page 107), writing of the Kiwai:—"The head was hung over a fire and all the hair singed off. During this process all the young girls of the village assembled and danced in a ring near—but not round—the fire, singing all the while. The head was then taken away, and all the flesh removed; after the skull was washed a carved peg was stuck in the skull, by means of which it was hung up on the main post of the house." And again (on page 115, of the Mawatta):—"Below one of the large houses there were clusters of human skulls hanging like bunches of grapes or strings of onions; these were the skulls of enemies killed in battle, and they were hung up as trophies."

* See *Journal*, No. 3,011.

They are, however, at liberty to return after having done so. It is said that ill-luck will overtake the Kagoro if they ever permit the making of pottery in their country. The Moroa also buy their pottery. The pots are black and quite plain, there being no decoration or varnish. Gourds or calabashes are of course very much used.

Metallurgy.—The Kagoro do not know that the stone implements found in the vicinity were once tools. As far as they know iron has always been utilised. When I pointed out the fact that only foreign blacksmiths had worked that metal for them (and are still doing so) they said that they did not know what had been used before. These blacksmiths in Kajji towns have special houses built very often in the form of a high cone. Brass is also obtained from traders. The only use I saw it put to was for ornamentation. The only silver in their country is our coinage, and this is too rare to be melted down to make ornaments as with the Hausas, but *tichiaks* are decorated with tin.

Machinery.—The millet or other stalks are first pounded by women in a wooden mortar to separate the grain. This is then winnowed in a flat shallow basket. The grinding is done with two flat stones, the lower one being placed at an angle inclining from the grinder to a calabash on the ground. The grain is poured on the higher end (near the woman) and by the time it reaches the calabash has become flour.

There are, I am told, no wells. They would not be necessary, as the towns are built very close to rivers.

Fire.—Fire, "which originated in the world from lightning," was formerly obtained from wood by the upright method. Several kinds of wood will do. The Moroa people say that they use this method even now in dry weather if not near a house.

The next method was by striking steel on pyrites or flint, and this is still very common.

It is now usually procured from the blacksmiths. When once fire has been brought to a house it is practically never allowed to go out except when fresh is sent from heaven,* and it is wonderful to see how long a stick will keep burning. Sometimes the embers are placed in chaff. Fires for warming (and also for cooking) are formed by putting three logs together so that their ends form a triangle, and a fire is lighted where they join. As a bit is burnt away the log is pushed towards the centre, and although there may be no flame this sort of fire seems to be inextinguishable—except of course in rain.

There is no religious reason for keeping the fire alight, I believe; it is simply for the sake of convenience, and—as with the Hausas—it will be gradually abandoned as matches are introduced, for the labour of collecting wood would then be lessened. The first fire for a new house is obtained from the nearest neighbour—if friendly; there is no need to wait in order to get it fresh from lightning.

Natural Forms.—No stone implements or arms are in use now, it is said. Gourds are employed as basins and drinking vessels, but not skulls (as, it is supposed, was done by the Ashantis). The pots made by the Attakkas resemble gourds. Some reeds are used for musical instruments.

No parts of animals are utilised for human defence. The Nadu have wooden helmets and skins to deceive animals, not the Kagoro now. Bamboo sticks with iron rings are used as clubs. Leaves of the fan-palm are sometimes laid on porches or outside shelters, but usually there is thatch underneath.

Writing.—There seem to be no writings nor even notches on sticks. As all villages are close together it would hardly be necessary.

I have not seen any representations of animals, etc., and none are scarified on people's bodies, but the natives understand English pictures.

They comprehended a rough plan of country drawn on the ground, but I have not succeeded in getting anyone to draw one for me.

To the bearer of an important message the sender may give a stick known by the receiver to be his as proof; the stick of the *agwam* is different from ordinary ones, and from that of another *agwam*, and most of the people have seen them at beer feasts, so they know them.

Weaving.—As there are no clothes there is no weaving done. I am told indigo is sold to the Hausas.

Agriculture.—Regular farms are laid out by everyone. The men dig and the women sow, the implements used being a hoe and a hoe-shovel used as a hoe.

These are made by the (foreign) blacksmiths, and are used after harvest as money in payment of tribute, giving of presents at death, cutting

* Sir Harry H. Johnston ("Liberia," p. 894) says:—"I have so frequently witnessed the ignition of the African bush by flashes of lightning, that I can well realise how the negro may have even been led into the use of fire by keeping alive and feeding the remains of a conflagration caused by the electric fluid."

off heads, marriage (to parents of bride), etc. No domestic animals are employed in the work of the farm.

Goat's droppings and ashes are used as manure. Land is allowed to lie fallow and there is a certain amount of rotation of crops, though this is better understood by the Moroa, who have but little spare land.

When the grain is ripening strings may be tied from one end of the field to another, and these are vibrated by a watchman (on a raised platform, probably, or in a tree), to keep off the birds and monkeys. If no string be available he will shout at short intervals.

Charms—bunches of leaves tied on sticks—are placed at the edges of the fields to prevent theft.

A man establishes his right to an unoccupied piece of ground by tilling it, and it is his until he allows it to go out of cultivation.

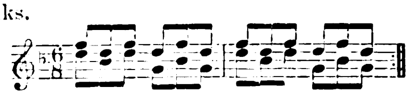
Trade, etc.—The fingers are always used for counting. For 1 the first finger is extended; for 2 the first two; for 3 the second, third and fourth; for 4 all the four fingers; and for 5 they are placed on the thumb. Both hands are used for the teens. For 20, etc., the hands may be opened and shut several times, or else the feet may be employed also.

There is no special class of traders, the bartering and marketing being usually done by the women. The custom of "the silent trade" does not exist.

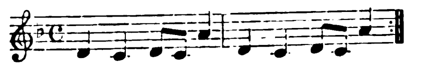
VI.—Music—Instruments—Dances.

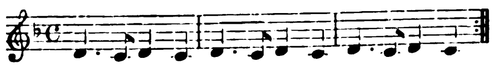
I was unable to hear more than one Kagoro song—and that, I believe, came from the Attakka. I could not get the words (which referred to marriage), but the refrain was—

A Kagoro youth accompanied his song on a native autoharp made of reeds. This instrument is common to many tribes, I have come across it even south of the Benue. I heard another tune at Fada Kagoro, but whether it was played by one or two boys I am unable to say, as I saw no trace of the player. The flutes on which it was played were made from guinea-corn stalks.



At Mersa (Kajji) I saw (and heard) a dance on three occasions. The instruments were horns and drums, one of the latter being large, and played like our big drum, the other was more of a tomtom. The horns were those of the antelope, two to three feet long, with a hole in the side near the point, and with about eight to twelve inches of a gourd fastened to the other end to give a wider mouth. A few of the players performed solos, and seemed to get sounds like those of a violin out of them, the intervals were so small they seemed impossible to write. The choruses were—





There are no words to the Kajji music, the people march round and round the band, taking three steps forward and then one back. Older women dance singly, but they may carry babies while doing so. Young women may catch hold of each other (as do the men), one behind the other, to the number of perhaps four; small unmarried girls may wear leaves for this. The women wag their tongues quickly from side to side and squeal. This sound is generally known by the Hausa name *kururua*. The dance is, I believe, intended to honour an important person; it was twice performed for my benefit, and once for that of a chief whom I had just appointed, but it—or something like it—is also performed at funerals. The band stands in a circle. After a time the big-drummer (the leader of this band) advances towards the centre, and is followed by the side-drummer and the horn players in turn. They go around a few times and then kneel in front of the person honoured for his reward. They never forget *that* part. An old woman may dance a *pas seul* at the same time, the other dancers standing still.

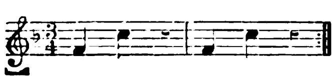
Another dance I saw was by Ninzams (also head-hunters) at Randa. Two men had drums, but none had wind instruments, the non-players holding short sticks in their hands. They sang the refrain several times (in Hausa) and then shivered violently. The translations are: "Our town is with (full of) young girls, the youths will have pleasure," and "Search for the whiskered one, ignore the salutation." What this last means exactly I do not know, and they could not explain, as they said the words had

been taught them by Mada (also head-hunters), who had evidently got them from the Hausa.

A few Hausa (or Filani) airs heard in Jemaan Daroro may be given, as they will probably be learned later by the surrounding tribes. The first is a woman's song; the singers move their bodies (particularly the buttocks) in time.

This is a serenade to the chief played several evenings a week on the algaita, a wind instrument which sounds like a clarionet. Sometimes the *e* in the last bar but one would change to *d* flat, an interval strange to our ears.

The last are salutations to a chief. The translations are: "See him, see him, see the King," and "May you alight (arrive) safely." They are played on long brass trumpets like



coach-horns, often in different keys. The time, three-four, is the nearest I can get, but sometimes it is very irregular.

Other Kagoro instruments are a flute and a kind of clarionet, both made of wood. A syrinx was found in Jigya, but whether this was native to the town or was imported I am unable to say.

These airs were not all in the key of *F*. I have written them thus for convenience.

VII.—War—Hunting—Relations of Animals to Man.

War.—There is a very close connection between the hunting and the war parties of these head-hunting tribes. A chase may easily be turned into a battle, even amongst the hunters themselves, when the arms for both are the same; and the search for beasts may become a hunt for men.

From the account given me by the Kagoro, it would appear that when they first came to the land they now occupy, they were dependent on the chase for their food, and that they lived in caves. Somehow or other they discovered the bow and arrow (even now the Gannawarri use spears on horseback), and began to drive off the dangerous, and kill the edible beasts.

It does not seem that all male adults must fight in case of war, but, judging by their general behaviour, I should not think any would refuse. The country is so small that the Kagoro are always within easy distance of their towns, so they go out in the early morning, fight by day, and return to sleep at night. They tried to surprise the patrol sent to punish them in 1908 about 9 p.m., but were unsuccessful. And this was the first night-attack Europeans had ever experienced in the district.* The warriors take food enough to last them for the day, but if fighting near their own houses their womenfolk will probably bring them something extra. There seems to be no need for any permanent organisation for war during peace, for all are in training, and none ever leave their houses without their weapons. Boys learn how to scout and take cover by practising with stones.

There does not seem to be any formal declaration of war, fights usually arising from sudden quarrels, but if there be any delay between the disagreement and the actual fighting, the women or people of a town friendly to both sides usually hear of it, and pass the word along.

Before a war is decided upon, the elders and priests repair to the sacred grove and ask the opinion of the ghosts. This is usually favourable, and then a leader is appointed, the *agwam wuta*. He is usually chosen for his skill in arms, and will not be either the chief or the head-priest, for these follow behind their troops, and cheer or drive them on as the case may be. Boys who have shown the right qualities in the sham fights with stones will be noted for posts as subordinate leaders when they grow up. Religion is conducive to warlike prowess, for (1) the strongest on earth will be the strongest in the next world, and (2) the ghost of a slaughtered enemy will attend the slayer. There is also, of course, the admiration of the belles of the village, and the effect of the stories and songs of the prowess of bygone heroes.

When the forces have assembled, the chief priest and the chief address them, and having

* Lieutenant Evatt, Middlesex Regiment, tells me that Mada and Nadu people attacked a patrol at night last year.

been handed over to the leader chosen, off they start. If in alliance with another tribe, the general of the tribe making the war will command the whole. Scouts are sent out in front to avoid surprise (up trees if necessary *), and to get news of the enemy, and the forces are disposed in accordance with the plan of campaign decided upon. When close to the expected battle-field the men extend. They keep a fairly good line but do not trouble about the step. All are on foot, there being but very few horses amongst the Kagoro; dogs are not used. They shout their war cry—*Wifu wifu*—and insult their enemies and boast of their own deeds.

When an enemy has been slain, the victor, on removing the head with his knife, will sing a special song about it, but there seem to be no other special songs. The Ninzam people have some, though, and sometimes the women accompany the fighting line, and sing to cheer them on. It is said that the Kagoro warriors do not sing any songs during the actual fighting.

Most of the towns are defended with labyrinths of euphorbia hedges, as mentioned before. There are caves in the hills, and here, if the town be attacked, the women will repair with their food and property. The men if driven out of the town may smash the beehives as they leave, so that the insects will attack the invaders. They seem never to have dug pits for their enemies, and this is surprising, for many of the surrounding tribes (Gannawarri, Ninzam, Yeskwa, etc.) do so. The Kagoro would be, I think, too much afraid of water to try inundating their enemy's country, but owing to the configuration such a course would in any case be impossible. Houses are never built on piles for purposes of defence, nor have the people any knowledge of earthworks, escalading or breaching, as there are no walls in the vicinity, but they cut paths through the cactus of other towns.

The weapons are (1) a wooden club, (2) a knife—bought from a Hausa or else made by a Hausa blacksmith, (3) the bow and arrow, (4) the sling, (5) the spear for throwing or thrusting, and (6) the shield. The arrows have iron heads with flanges, and are poisoned, the shafts being notched but not feathered; they are usually about 3 ft. in length, but Jigya used some 4 ft. 8 ins. long against the Patrol last year.

* Lieutenant Matthews writes:—"One of the Mada methods of fighting I have not heard of elsewhere. They tied goats to the bottoms of trees, the tops of which were covered with creepers, and, when people came to unloose them, they sniped them."

Fire-arrows are unknown. The bow is not strengthened in any way, though a ring may be placed on the thumb when drawing it. I have not seen a sling; the Sa(r)rikin Jemaa, however, assured me he had been wounded by a stone from one at Jigya: this may have been thrown from the hand, of course. Stones are not usually rolled down on the enemy, but the last British Patrol was attacked in this way. The spear has an iron head with flanges, and a small piece around the end of the butt; it also has a small projection on which to rest the forefinger. The shield is round and made of hide, bullock for preference; I believe there are some of grass, also, but did not see any.

The chief causes of war are the capture of women or else the murder of men. Feuds may last a very long time between tribes, for children of a man killed, even in battle, will keep up the vendetta. The Kagoro have not amalgamated with any tribe: in fact, although they repeatedly defeated the Kajji, they seem to have never followed up their victories nor to have deprived them of any land, though this happened indirectly, because the Kajji were too frightened to go to any farms near the frontier. I should not think that knowledge of any of the arts or culture of other tribes has come to the Kagoro through war, nor has migration been promoted by it to any great extent.

When one side is tired of the war any women who once belonged to the other tribe, but have been married to men of the tribe wishing for peace, are sent to their relatives as ambassadors, and they are naturally sacred, for they have friends on both sides. If peace is agreed upon, representatives of both tribes meet and swear friendship.

There is no general division of spoil, each keeping what he takes.

Hunting.—Notices are sent around when parties are to be formed; they are—as mentioned before—practically identical with war parties except for the fact that the chief seems to have more power than in an organised expedition. The ghosts are consulted (three days' beer-drinking), as before a war.

There are practically no large animals now in the Kagoro country, so the rat and field-mouse are the only "game." Most of the grass is burnt off during November and December, and these animals can no longer conceal themselves, fire apparently being employed more for the purpose of clearing the ground than for driving the quarry. Sometimes patches of grass (perhaps 12 ft. high) are left, and these

are trampled down, so that the inhabitants will be driven out into the open where the men are advancing in line, with their arrows fitted and bows stretched. I have twice seen hunting parties, but no "game," so I do not know if the men are good shots or not. I should think they must be though, for "hunger maketh a good marksman," and unless they could hit a target when they got the chance it would hardly be worth while looking for it.

Each party keeps to the limits of the land of its own town when hunting singly, but usually men of several villages join together. There are, I understand, no game laws, each man getting what he can, where he can, when he can. The hunts will last from early morning until sunset, and some men will be away every day from November to March. The harvest is over (October—November), the houses have been re-roofed (same time, *i.e.*, before the grass is burnt), and there is no planting until April or May, so there is nothing else to do but to "kill something."

There is only one permanent blacksmith amongst the Kagoro * (a Hausa-Filani from Dangoma). He told me that he made all his arrows of a similar pattern, so that everyone who buys from him has the same kind of missile. All, however, do not patronise their home industries, but go to Jemaan Daroro, Zangon Katab, or Moroa for them, and there are several patterns. In addition to this there is no doubt that some private marks are made: at any rate, everyone knows his own arrow. This is important, because all game belongs to him who first wounds it. Even if the wound be slight, and the beast be despatched by another, the carcase will belong to the owner of the arrow if it be still sticking in the body, for it is held that it must die eventually owing to the poison. It sometimes happens therefore that one man will pluck out the arrows of another so that there will be no proof of ownership, and this leads to quarrels and fights between the various partisans, especially if the disputants be of different towns. Men have been wounded in these miniature battles, and even killed. If there be no means of deciding to whom the beast belongs (say if it has escaped, has got rid of the arrows, and is killed by other men who did not see it wounded) the claimants will be required to go through an ordeal, or it will be divided amongst the whole party. The owner of the carcase takes it to his own house, where it is eaten by the family and relatives. He is not compelled to give any of it away, though he may ask the *meakwap* to the feast, and perhaps even the *agwam.* As with us, a man may try to purchase popularity if trying for any office. The poisoned meat does not seem to be dangerous.

I have not seen any game stalking (nor game), so do not know if they dress up to represent their quarry. The Nadu (cannibals with pierced noses to the south) do, however, and have a wooden helmet with horns to which a hide can be attached. Pits were dug for animals in the old days but not now, and there are snares for birds I am told. Dogs and horses are not used, but with the Gannawarri and Kibbo most of the members of the hunt are mounted, and they drive in a very large circle which constantly decreases, everything in sight being slaughtered and eaten. This procedure soon exhausts the game in the country; no doubt the Kagoro did the same kind of thing formerly.

The weapons are the same as for war, the arrows all have a similarly shaped head (there is no distinction for different sized animals), with only one point. Weapons are made to kill, or at any rate disable, so that the flesh may be secured; the skins are only a secondary consideration. It is no reproach from a huntsman's point of view to wound and not capture an animal, but the relatives—who would thus miss a feast—might have a word or two to say in the matter. Only men take part in hunting and fishing.

So far as I know, there is no fishing with a baited hook, but I am not certain whether small cast-nets are used or not. Fish traps are made of cane, the idea being the same as in our lobster pots, but those of the Kagoro are much longer in proportion to the breadth.

It must not be thought that the women do all the work. If the tasks be reckoned up it will be seen that each sex has an almost equal amount. The men do not work as regularly or continuously as the women, but while they are at it they undoubtedly have to expend more energy; they do all the hard work. Certainly they have chosen if not the wiser at any rate the more enjoyable part, for hunting animals gives more pleasure than searching for firewood, fighting enemies more excitement than "minding the baby." However, the division of labour must always be on much the same lines in

* The southern towns get what they want from Jemaan Daroro. The Moroa too have only one, the Kajji several. Sometimes travelling smiths visit these tribes just before the wet season, when there will be a demand for hoes.

primitive societies, for the male's superior strength and health enable and entitle him to choose his tasks. Men clear the ground for the farms because women are not strong enough, they hunt because women are not able to do so, they fight their enemies to prevent them carrying off their women. It is at this time, I suppose, that the division of labour takes place. The male is watching his enemy and his attention must not be distracted lest he be surprised, so the household duties naturally fall to the female. When he does return he is too tired to collect firewood for fuel, so *she* must. Hunting is a natural training for war, and as such, and because it is fatiguing and takes him away from the home, it falls to the man's share. Nature prevents women competing, for at certain times they would be unable to fight or hunt, and so the whole community would suffer if dependent upon them, and they would either have to bear no children so as to be free in their movements, or else be forced to take their offspring with them, and so be an easy prey to a swift enemy, and quite useless as huntresses. However, this is hardly the time to enlarge upon such a subject. Labour seems to become sharply defined into men's tasks—those to do with the protection of the home, and women's tasks—those actually in the home, and as the latter are not dangerous they are looked down upon as "women's work"; and this is true not only of members of primitive societies but even of the most advanced people, who ought to know that neither kind of work can be performed alone because they are dependent on each other.

The relations of the native to the official are usually unfriendly at first, so perhaps I ought to have described the war parties earlier; but later on better understandings arise, and I think you will agree that in this slide there is not much sign of disagreement between the people and myself.

Relations of animals to man.—The horse is not used in war or hunting. The Kagoro and Kajji have but few, the Moroa and Attakka a fair number brought from Zaria. They are about thirteen to fourteen hands high and rather weak. The bridle is made of leather sometimes ornamented with brass. There is no bit, but a toothed half-hoop of iron passes behind the animal's jaw to join a similar half-hoop above the nose, and can be tightened by a pull on a rope on the left side which forms the rein. The saddle—if any—is a goatskin tied on to the back. Some of the pagans in the district make a cut in the skin over the backbone about a foot long and open it out, so that the flesh swells up and forms a pad, which, after a time, seems to become callous. There are no mules nor donkeys.

The dog is used as food, and always forms part of the marriage gift. It is a poor specimen —I fancy only one breed, they all look the same—but since it is a cur it makes a good watch-dog, and it also acts as a scavenger.

No cattle are kept, but goats and sheep are. The flesh is the only part used for food, not the milk. Clothing is made from the skins.

There seem to be no mythical animals, but when the ancestors of the Kagoro came to the country wild beasts are said to have been numerous. I have not heard of any monsters in the water; the crocodile is present (in the Kaduna) and he is sufficient for their imagination. Some say that animals have souls, others say not: the latter seems to be the more widely accepted view. Certain names of animals are given to children, as well as those to commemorate events; *Jin*, the hedgehog, and *Zat*, the buffalo, are common, also *Kura* (the Hausa name for) the hyaena.

No animals nor birds are used for game fights, but a fowl can act as deputy for a human being in an ordeal. A fact which at first strikes one as being very strange, but which on second thoughts appears quite natural, is that animals understand only the local languages. In Amar (Muri Province) in 1906 I bought a cow from some Filani people (the great cattle-breeders of Nigeria), but could get no milk from her although she had a calf at the time, the excuse given by my servants (all Hausas) being that "the cow could *talk* only Filani," and would not give them her milk. I, of course, thought that the real reason was laziness, but on getting a Filani girl from the barracks found that the animal was quite tractable, and would give milk in plenty. The other servants caught and held the cow, so their work was not much reduced. This would not be enough by itself to prove anything, for the Filani girl knew much more about the management of cattle than the Hausa boys did, but I noticed in 1909 that dogs and horses procured in Moroa were quite at a loss when told to "Come here" or "Gee up" or "Whoa," and when we think of it, if English pets were addressed in an unknown tongue they would not comprehend, so there seems to be no doubt about the matter. After all, if the people themselves did not understand a foreigner's language, it is hardly likely that their animals would.

In concluding this paper, which, although very long, does not give anything like as complete an idea of the people as I should like to convey, I wish to express my thanks to Lieutenants Matthews and Evatt for reading over my notes and offering valuable hints, and to the Board of Anthropological Studies at Cambridge for much sympathetic help and encouragement. Not that a student, when once he has commenced "the study of man," requires very much encouragement! I defy anyone to live for any length of time amongst such primitive peoples, and not become very fond of them. He need not, in fact *must* not, spoil them; it is almost better to be too severe at first than too lenient; they appreciate a strong "Over-Chief." I managed to collect nearly three years' tribute in a little over twelve months, and yet think I was not half so unpopular as Form IV. They are rather smelly folk, certainly, and in other respects fall somewhat short of *our* standard of life, but, on the whole, one can really admire them—even though one has to fight them.

My Camp at Mersa (Kajji).

The last slide gives an idea of the beauty of some parts of the country of the Head-hunters, and I am sure you will agree that I have a good deal of excuse for being fond of it and them.

DISCUSSION.

Surgeon-General G. J. H. Evatt, C.B., in opening the discussion, thought everyone present would agree that the author had given a most searching and interesting study of Northern Nigeria. His own remarks had a certain personal element in them, because his son was a lieutenant of an English regiment which was sent out to Nigeria, where he had the good fortune to command the troops who were with the author at Jemaan Daroro. He very much wished that, during his own service in India, China, and different parts of the world, there had been somebody present who could explain the customs of the various countries which he had been in. It seemed to him a great pity that so many thousands of English soldiers went to many different countries and never heard anything of the meaning of the customs which existed therein. The author was a trained anthropologist. Instead of merely amusing himself, as some other officers did when they returned from service abroad, he at once went to Cambridge, where he studied Anthropology, and was the first to take the newly-established diploma in that subject. Through the knowledge he had thus acquired he was able to teach to the uninitiated facts which they would pass by as of no importance; and those records passed round the circle of the world and gave information with regard to the origin of things far away which otherwise would never have been dreamt of. The author had referred to the question of the sacredness of fire. The reason the Vestal Virgin was not allowed to have a sweetheart was that she was so sacred. If she passed down the street and a prisoner who was coming up the street saw her, that prisoner was at once acquitted. She was so sacred because she was the match-box of the age. The care of the fire was her sacred duty. When once the fire was lit it was not allowed to go out, because the making of fire was so important. Exactly the same sort of thing prevailed in Nigeria. His travels round the world had taught him to appreciate the fact that the study of anthropology would make foreign service infinitely more interesting than it was.

Dr. HERMANN K. W. KUMM thought it would be of great interest if the author could state whether anything was known about the language of the people he had been describing, and what relationship it bore to other languages spoken in the hill country, so that conclusions might eventually be arrived at as to whether the people belonged to the Bantu family, or whether there was any relation between the Hamitic races and the tribes of head-hunters of Northern Nigeria.

Mr. T. C. HODSON said that he had served as an officer on the Indian frontier, where head-hunting was in full swing ten years ago, and there seemed to be something of a comparison on anthropological grounds between head-hunting in Nigeria and head-hunting in Assam. In the first place, head-hunting in Nigeria was stated to be something in the nature of a mark in social evolution, *i.e.*, a young man showed his fitness for marriage by producing a head. Davis, in the Assam census report for 1901, pointed out that that was exactly the cause of the head-hunting in that country. Nowadays many a young Naga was unwedded because the authorities had rigorously put down head-hunting. Another cause of head-hunting was the vendetta pure and simple. No feud could be allowed to rest until the arithmetical tally of heads was exactly equal on either side. He remembered on one occasion visiting a big village of eighty houses, and insisting on the exchange of all the heads between that village and the neighbouring village with which he was endeavouring to make peace. The exchange of heads was quite an interesting function, some of the heads having been kept for over twenty years. Records existed which showed that that particular village had been burned twenty-two years before, and all the heads destroyed by the fire, and in the course of twenty-two years something like 400 heads were obtained, all of which were duly returned. In another case he found that head-hunting was practised as a rite precedent to the cultivation of the fields, it being necessary to cut the head off the body and show the head to the fields so that the fields might be prosperous in the coming year. A similar feature existed in the Trieteric festivals of early Greece. Another interesting point was the taboo placed on the occupations practised by women when they went to a strange tribe. He remembered going to a strange village where weaving was not a special industry, and found that a woman who had come from one of the weaving villages was not allowed to practise her craft for the reason that the villagers feared the magic of the craftsman. In those villages each small group tended to practise one special or localised industry. One village made mats, another had a weaving industry, while others had a monopoly of iron manufacture. The beginnings were thus seen of the caste system, so far as its economic development was concerned. One feature of the paper which was particularly interesting was that head-hunting was not divorced from the mass of customs in which it was found. It was very common to hear papers read in which one custom was wrenched apart from its context, whereas it had its real value only in reference to its context. That was the great lesson that scientific anthropology was teaching, that the customs of natives must be looked upon as a whole.

Major LYLE CUMMINS, R.A.M.C., said he understood from the author that the incision marks on the chests of the women were made when they were married, and not at a particular epoch in their lives. He noticed from one of the photographs that the incision marks on the forehead of the men were very similar to the marks he had seen among the Dinka tribes. There the marks ran horizontally instead of vertically, but they marked a distinct epoch in the life of the young male, being put on the head of the Dinka when he attained manhood. He would be very interested to know whether, among the male head-hunters, the incisions were put on at a definite epoch. Reference had also been made to the question of the use of native beer as compared with English gin. In the Sudan, native beer was consumed in enormous quantities, and drunkenness caused by it was very frequent, but it lasted a very short time. The natives got drunk very quickly, but were sober again in a couple of hours. Drunkenness was quite a daily occurrence among the natives who could afford it, and it seemed to have little effect on their health. As a medical man, he had been struck by the fact that it apparently did them so little harm. It would be of interest if the author could state whether he knew how much alcohol was contained in the native Nigerian beer. His own impression was that European spirits were much more harmful to the health of the inhabitants of the Sudan than native grain beers. Definite information on that point would be of great medical interest as well as of economic interest to those who administered native races.

Captain TREMEARNE, after thanking Surgeon-General Evatt for the kind remarks he had made, stated, in reply to Dr. Kumm, that he started to learn the language, but nobody else had learned any of it yet. He was afraid, therefore, sufficient material had not been obtained to understand much about it. As a matter of fact he did not get into the grammar of the language. He had made a vocabulary, which had been deposited in the Cambridge University Library, and could say a few sentences, but that was all. He had been interested to hear that several of the customs in Assam were the same as those prevailing in Nigeria, and he had mentioned in the paper that Dr. Haddon had found the same sort of thing existing in New Guinea. The heads obtained were kept and hung up outside the roofs, generally under the thatch. While he was in Nigeria, in March 1909, there was a great beer-drinking festival, during which

a cannibal tribe, the Gannawarri, sent some representatives to visit the Moroa; and during the festivities five of the men were shut up in a house, killed and their heads cut off. War was threatened, and he had to try and stop it. He thought the only way to do so was to get the heads back, although the Gannawarri did not seem to want them very particularly; but as a matter of fact he did get them back, and they were now in the Cambridge Museum. Mr. Hodson had mentioned that the Nagas cut off the head from the body to show the fields in order that there might be a prosperous agricultural season. The Kagoro sacrificed a fowl, and it was quite probable that they might have sacrificed a human being earlier in their history. With regard to scarification, the men and women had the same marks on the head, but in regard to the body it was different. It was voluntary for the males to have marks on the body, but the females must do so. The chests and backs of girls were scarified, and when they were married the foreheads also. With regard to the question of native beer and European spirits, his opinion was founded on the report of the committee which inquired into the question of alcoholic drinks in Southern Nigeria about two years ago. Much the same beer was made in Southern Nigeria as in Northern Nigeria, and if it was worse there than the English article it was probably worse in Northern Nigeria also. A great outcry had been made against the importation of gin, but he did not see how the importation could be stopped. There was a great amount of it going into Northern Nigeria, although officially they did not know it, but they might just as well recognise it officially and get revenue from it. Sir Harry Johnston had said that the use of that much despised form of alcohol, trade gin, in Liberia, as in other parts of West Africa, seemed to be much more misunderstood than anything else. In fact, in many parts of Southern Nigeria gin was never drunk at all; it was simply used as currency. If it was admitted into Northern Nigeria, although some of it would of course be drunk, a great part of it would probably be used for trading purposes. He did not think it would do much harm, and the Government would obtain revenue, which it badly needed.

The CHAIRMAN, in proposing a hearty vote of thanks to the author for his paper, said he remembered that an old friend of his, General Lobley, used to take a great interest in the subject, and wrote a book called "The Head-Hunters of Borneo." He used occasionally to call upon him (the Chairman) with a black leather bag in his hand, from which he used to abstract a human head, the merits of which he would explain, and he remembered General Lobley telling him that such heads were very often taken by a young man in order to ingratiate himself with the fair sex. He congratulated the author upon the musical talent he had displayed. It was a very unusual occurrence to have a lecture in the historic hall of the Society accompanied by music, and when the author was playing the quaint native dances, he felt quite sorry that some of the ladies who were depicted in the slides were not present to show how the dancing was performed.

The vote of thanks was then put and carried, and the meeting terminated.

EIGHTH ORDINARY MEETING.

REPORT OF THE DISCUSSION ON THE PAPER ON

EXAMINATIONS IN THEIR BEARING ON NATIONAL EFFICIENCY.

By P. J. HARTOG, M.A., B.Sc.

(*Continued from p.* 291 *of the* Journal *of February* 3, 1911.)

Dr. H. A. MIERS, F.R.S., Principal of the University of London, thought that, whatever change was made in the examination system of the country, it was necessary not to forget a certain part played by competitive examinations at the present time. One of the chief functions of education was to stimulate people to work for themselves and not merely to receive from others. There was a vast number of students, both at schools and universities, who had no desire to learn, and therefore required some stimulus to urge them to teach themselves. If the examination stimulus was removed, bad as it might be in some respects, it might be necessary to replace it by some other stimulus for the sake of the less willing students. With regard to the question of examinations as a test of general capacity or general intelligence, he was very much struck with a paper read at the Sheffield meeting of the British Association by a gentleman who visited a school where the boys were being examined for scholarships, and who obtained permission to apply his own tests in order that he might compare the list of passes according to his tests with those given by the ordinary scholarship examination. He made a sporting offer that if any boy obtained a scholarship by the one test and did not gain it according to the other, he would pay the scholarship fees. He applied the usual intelligence tests, with the result that his list was absolutely identical with the list obtained by the ordinary scholarship examination method. From that a conclusion might be drawn that it did not much matter in which subjects the boys were examined, and doubt might arise whether as a test of general capacity the particular examination method or subject was of very great importance. He wished, however, on the present occasion to endorse the conclusion of the author, that the need had arisen for an inquiry into the present methods and systems of examinations—as to whether they were adapted to the purposes they were supposed to fulfil. In view of the figures quoted by the author, which were very far from complete; of the enormous amount of time and

money spent upon examinations in England at the present time; of the large number of poor teachers who were inadequately paid for teaching and were driven to supplement their income by examining (the question could well be asked whether the money might not be better spent in paying them more for their teaching); the time was ripe for inquiring whether that vast expenditure of time and money was being utilised in the best posible way and leading to the best possible results, and he trusted that one of the results of the paper would be that an exhaustive inquiry would be made into the present examination methods of the country.

Professor JOHN ADAMS desired, as a teacher of teachers, to emphasise the teaching function of examinations. Anyone acquainted with the teaching of students knew that part of their work in preparation for teaching was to be able to set an examination paper, and to that extent, therefore, students were taught how to examine. The point that struck him most in the paper was the admirable selection of points of view chosen by the author. He wished to emphasise the difficulty of interviewing mentioned in the paper. He had just come from interviewing 150 students for selection for his own college, and it had given him the greatest possible anxiety to determine which of those students to choose, owing to the very different qualities of the students presented. The examination those students had to pass might be good, bad, or indifferent, but it showed whether or not they were good at passing examinations, and the main element he had to consider was whether a student coming to the college would be able to pass another examination three years hence. He had no doubt whatever that he could manipulate his students for examinations, as he had known students manipulate examiners. He remembered one student who was being examined, pretending that he did not know the difference between sulphate of copper and sulphate of iron, in order that the professor who was examining him might not question him further in regard to iron, on which subject, however, he had been specialising. That sort of thing was done all round, and had to be taken into account in connection with examinations. He had certain very firm convictions with regard to the capacity-test as compared with the knowledge-test. The knowledge-test acted as a sort of false function with regard to pupils. As an examiner, he laid it down as a universal rule to "pluck" a man in every case where he had not the requisite knowledge of the prescribed books, whatever his abilities were. Examiners were appointed in those circumstances to determine whether the student had done the work which the examiners had to test. On the other hand, there were particular examinations in which that process might be reversed. He contended that a boy should be examined in English literature, not in a room bare of books, but in a library; and that a boy should be examined in geography, not in a room in which the maps were turned to the wall, but with an atlas by his side and as many maps as he could use, because he had found that a boy who did not know where to look for things was absolutely hopeless. He had known a man go into an examination with every proposition of Euclid hidden about different parts of his person, and come out "plucked" because he could not find the place. In conclusion, he heartily supported the author's recommendation that an inquiry should be held for the purpose of throwing more light on a subject on which so much difference of opinion existed.

Dr. A. C. HEADLAM, Principal of King's College, London, said the result of his large experience of examining was that there were certain examinations, within certain limits, in which the result might be fairly satisfactory and the effect not unwholesome. Those were examinations conducted, in the first place, by a board of persons acting together, who not only marked the papers but talked over the papers with one another. In the second place, the great majority of the members of that board were the teachers of the persons being examined; and, in the third place, they were able to supplement, not necessarily in every case, any literary examination by means of *viva-voce* examination. With those three conditions the result, for the particular purpose in view, would be fairly satisfactory. But of course it was necessary always to consider what the purpose in view was. It was his experience that if six examiners looked over the papers and compared their results, in quite ninety cases out of 100 they would find their results coincided, if they were fairly capable and suitable examiners. In 10 per cent. of the cases, however, very great discrepancies would occur, which necessitated not only re-reading the papers, but discussing them very carefully. The individuality of the person taught, or some similar reason, was the general cause of that great discrepancy; but with a board working together the result was generally fairly satisfactory. That meant that an internal system of examination should be aimed at. The fundamental point under consideration was how to get good men for the public services under those conditions. When Lord Cromer was selecting men for the Sudan, the first point he laid down was that they were to be university men, *i.e.*, that they had gone through a certain necessary system of training in life. Looking into the future, it seemed to him the main principle which would have to be adopted was either selection out of a carefully-selected body of candidates, or the examination of a selected body of candidates. It would be necessary to lay down that all the candidates for a certain post must be persons who had been through the university and obtained certain marks of distinction, and a certain number of those would be selected or examined. In a similar way, for certain other appointments, it would be necessary that a certain number of years should be passed at a recognised public school, care being taken that the

educational system provided facilities for everybody. In that way, what he might call the tyranny of the external examination system would be abolished. He remembered Mr. Gladstone once saying there was one thing which must be remembered in connection with examinations, namely, that a person was compelled for a certain number of hours to learn—to concentrate his mind on certain points. That taught men the valuable habit of concentration, and therefore he thought internal examinations were very valuable if carried out under proper conditions. Personally, looking back on his own career, he did not feel that examinations had done him any harm; but, looking back at the career of a number of other people who had been prepared specially for external pass examinations, the result seemed to have been in their case to make them have no interest in learning or in intellectual pursuits at all, but to make them regard learning as only aimed at passing examinations. It was more in relation to the parents that the examination system was bad. There were many parents at the present time who looked upon schools as merely places to prepare their children for examinations in order to get posts. That, unfortunately, was the result of the excessive examination system in the country. He did not know what the Chairman wished the audience to draw from the small autobiographical account he had given, but it seemed to him (Principal Headlam) to suggest that there was a good deal to be said for authorities being able to interfere, even with a medical examination!

Professor Arthur Schuster, F.R.S., said he could not point to any part of the paper with which he was not in agreement. The problem, however, was to find some way of making progress, because people had been saying most of the things said by the author for a good many years, but nevertheless matters were no better now than they were ten or twenty years ago. The paper and the discussion had made a little clearer to his mind than had been the case previously, that a sharp distinction must be drawn between the examination requirements for academic purposes and the requirements of selection for the public services. In the public services a certain amount of competition could not be avoided. A definite number of vacancies existed, which must be filled in some way or other by selection or competition. But in a university examination it was only necessary to decide whether a man was fit for distinction or not, as the educational authorities were not compelled to confine their awards to a fixed number of men. The great subsequent difficulty in the public services did not seem to him to be so much to select an efficient person, as to get rid of the incompetent person when the examiners had made a mistake. There was no country that gave so much consideration to the incompetent man as this country. Even in the universities the teachers were entreated to have regard to the weak students, the students who did not want to learn, and more or less to neglect the competent man in consequence. In regard to the actual power of examinations to test, he had never had any fear that a certain definite standard could not be maintained. He had had a good deal of experience in one limited subject in which he never had a large number of students to examine, but it was quite surprising how near different examiners got in marking the same papers. He was certain, however, there were very great differences very often in the standard of pass from one year to the next. The ingenious and acute remark was made to him by the late Dr. John Hopkinson, after he had been serving a term of office as an examiner for the old London University, that he was quite sure the right way to conduct an examination, where there were at least one hundred students, was not to fix the standard by a minimum number of marks for a pass, but to "plough" a fixed percentage of the students every year, because the standard of the papers was much more likely to vary than the standard of the candidates. He would have liked to discuss in detail the question of the competition which was introduced very often into university examinations. It had been thought that some of that competition had been got rid of by abolishing the order of merit and simply substituting classes, but in some respects this had made the matter worse. It was a serious matter whether a man obtained a first or a second-class. A man who was really quite safe to get a first-class was so afraid that he might only get a second, and his career might be ruined in consequence, that he devoted his whole time, which might be more usefully occupied, to making sure of getting his first-class. He had recently spent some time in India, where he had studied university questions. The university examination system had been imported from this country into India, and it was having the most disastrous effects there; and he was quite certain that the whole educational system of India required reconsideration from that very point of view.

On the motion of the Chairman, a vote of thanks was accorded to Mr. Hartog for his paper, and the meeting terminated.

HOME INDUSTRIES.

Port of London Improvements. — The Port Authority was established mainly for the purpose of improving the dock accommodation of London, of bringing it up to the requirements of the greatest of existing ports. In this direction London has not kept quite abreast of the times. Huge sums have been spent by the State and Municipality in the improvement of the docks at Hamburg, Antwerp, and elsewhere. In London, competing interests and conflicting authorities delayed improvements admitted to be imperative if she was to hold her own as the first of ports. The Tilbury Dock was opened a quarter of a century ago;

since then there has been no great dock improvement, and since 1886 nothing has been undertaken in the Port of London to meet the continually increasing size of vessels. How enormously size has increased is very clearly shown in the memorandum just issued, in which Mr. F. Palmer, Chief Engineer to the Port Authority, explains the scheme for improving and extending the dock accommodation of the port. Since 1886 the increase in the average size of the largest vessels represents a growth in length from 450 feet to 700 feet, or 55 per cent.; in beam from 52 feet to 77 feet, or 48 per cent.; in draught from 28 feet to 35 feet, or 25 per cent., and in gross tonnage from 7,000 to 24,500, or 350 per cent., whilst the volume of shipping using the Port of London has grown from a net register tonnage of under 12 millions to over 18 millions. The Port Authority now recommends improvements and extensions estimated to cost 14½ millions, but it is not proposed to incur the main portion of this expenditure immediately. Lord Devonport divides the projected works into (1) primary or urgent; (2) secondary; (3) contingent. The estimated cost of the work to be set in hand immediately—assuming Parliament assents—is put at rather less than £4,000,000. This would provide a great extension of the accommodation available at the London at Wapping, the West India and Millwall in the Isle of Dogs, and the Victoria and Albert group lower down. Nothing is to be done on the south side. The Surrey Commercial Docks have in the Greenland the most recently-constructed dock on the Thames, and meet present requirements. It is proposed to build an entirely new Albert Dock, to be called the South Albert, parallel with the existing one, and between it and the river, with new entrance lock, dry dock, quays, and sheds complete. It is estimated that this will cost 2½ millions. About a million is to be spent on the West India Docks, where there will be a new entrance from the river, with a new basin and quays, new dry dock, and many internal improvements. At the London Docks it is proposed that the entrance be reconstructed, and there will be a large increase in quay accommodation. Later on there is to be a new and very large dock on the north side of the existing Albert Dock, which will cost over 4 millions; extensive additions at Tilbury, and improvements at the Albert and Victoria Docks, the East India, and the Millwall. In preparing the scheme which has now received the final sanction of the Port Authority, Mr. Palmer took the fullest possible advantage of gathering information from sources competent to give good advice and guidance, from men like Sir William White, Lord Pirrie, Sir Thomas Sutherland, and Sir John Ellerman, with the result that he is able to say the leading shipping interests think well of his scheme. It is not to be supposed that its details and estimates will not have to meet close scrutiny and sharp criticism. Close and careful independent examination is necessary, but it may be taken that in its main conceptions the scheme will prove acceptable to Parliament. If adopted, leeway will soon be made up, and future needs sagaciously provided for.

Land Values.—There has been some discussion, prompted by Mr. Walter Long's decision to sell a portion of his Wiltshire property, as to whether such sales of land are likely to add to the seller's income, and although experts differ as to what the average selling price is, it seems pretty clear that where estates are moderately rented the large landowner is likely to increase his income materially by selling a substantial portion of his property. Assuming that an owner can sell at twenty-five years' purchase on the net rents, and that he can reinvest at 4 per cent, he will benefit considerably by a sale. Of course there is a great difference between twenty-five years' purchase on the rents, after deducting tithe and land tax, as compared with a net return after allowing not only for tithe and land tax, but also management, repairs, insurance, rates payable on cottages, village property, etc. Mr. Howard Frank, who is able to draw upon a wide experience of land sales, says the owners who have sold during the last two years have in every instance benefited financially, after allowing for all costs of sale, and he tells us that the estates he sold during last season realised an average of twenty-seven years' purchase upon the existing rents, after deducting tithe and land tax, but not on the gross rents. This is a sufficient indication that in the majority of cases rents were low. It would seem, therefore, that owners who have decided to realise a portion of their estates, reinvesting the moneys in securities that can be sold more readily as occasion arises, are acting prudently, more especially having regard to the tendency of modern legislation and the rate of the death duties. Whether the tenants will be generally benefited is not so certain as many take it to be. Indeed, so far as the old-fashioned landlords are concerned, the men who do not exact a rack rent, and do not dream of disturbing a tenant if he does his duty by the land, tenants must often be prejudiced by the present tendency to sell. The majority of tenants cannot afford to purchase their farms, for their means are not enough to allow them to buy the land and stock it. On the other hand, it is hard that the land should be sold over their heads and get into speculators' hands when, as under the Irish Encumbered Estates Act, either the tenant has to pay an increased rent or be turned out.

Atmosphere in Gassing-rooms.—A writer in the *Manchester Guardian* suggests that advantage might more frequently be taken of the very efficient appliances available for the improvement of the atmosphere in gassing-rooms. There is probably no process in cotton spinning or manufacturing which involves more discomfort to operatives than is occasioned by the vitiated atmosphere generally experienced in these rooms, and ventilation by means of fans placed in the ordinary way either in the roof or walls of the rooms is very inadequate.

Several effective devices are available. In one of these the gas-jets are enclosed in vertical shields which are connected to metal trunks, the latter being exhausted at the outside by means of fans. This appliance has been fitted in gassing-frames in several new mills in Lancashire and Yorkshire, and the rooms are quite free from obnoxious fumes. Another device consists of a duct attached under each machine and connected by trunks to fans which are fixed in the roof. It is to be regretted that many of the older mills are slow to adopt such appliances as these. In many cases the additional expense can hardly be a consideration, and probably would be more than compensated by increased efficiency in operatives resulting from improved working conditions.

The Outlook for Coal.—There has been no abnormal demand for Welsh coal. The aggregate trade is slightly heavier than the average of last year, that is all. And yet colliery owners are quoting for supplies over the next three months at from 9*d.* to 1*s.* per ton above the figures quoted two or three months ago, and for the six or nine months at an average over their December prices of 6*d.* to 9*d.* per ton. Two reasons are given for the upward movement apart from the usual holiday pressure and the practice of merchants to close their commitments with the colliery companies—the cessation of work in the Rhondda and Aberdare Valleys, and the restrictive influence on production of the Eight Hours Act. The trouble in the Valleys reduced the output during November and December by something approaching 50,000 tons per day. The consequent congestion would have been relieved much earlier but for the effect of the Eight Hours Act. Immediately there was a market in which the prompt demand has to some extent exceeded the supply, the hampering effect of the Act was felt. The collieries have failed to expand their outputs as was the custom before the Act came into operation. In many of them the production is from 10 to 16 per cent. lower than it used to be, and the new workings have not been developed sufficiently to make up for the difference. It is estimated that labour legislation has added at least 2*s.* per ton to the cost of coal since 1842, which means, with the present output, £26,000,000 a year. But most of this was incurred in better safeguarding the miner at his work, and so is not begrudged. No part of the additional cost of coal to be attributed to the Eight Hours Act increases his security; on the contrary the weeding out of the elderly and experienced miner, and the hustling, which are the direct consequences of that Act, must tend to make mining accidents more frequent.

The Declaration of London. — Almost all the Chambers of Commerce and shipowners' organisations throughout the country are protesting against the ratification of the Declaration of London. The chief objections to it, from the British point of view, are concisely put in a resolution recently passed by the Swansea Chamber of Commerce. It objects on the following grounds:

"1. The effect of the Declaration is to change, in an entirely unprecedented manner, the law of nations as hitherto maintained, and to introduce a code, which, in its effect so far as the regulation of our naval operations is concerned, would be highly prejudicial to this country.

"2. The wide discretionary right which the Declaration gives to foreign naval commanders to capture and destroy cargoes of foodstuffs in neutral vessels destined for this country when a belligerent, lays the oversea food supplies of this country open to alarming contingencies, the dangerous effect of which must not be under-estimated.

"3. The absence of any reference in the Declaration restricting the conversion of merchant vessels into warships on the high seas, and the determined opposition with which our delegates at the Naval Conference, in their efforts to arrive at an understanding on this point was met, makes the matter of such crucial importance as to warrant the abandonment of the treaty."

It is less probable than it was that the Cabinet will seek to ratify the Declaration as it stands. Much will depend upon the view of the Imperial Conference, which will consider it in May.

New Insurance Companies.—Last year twenty-nine insurance companies were registered, with an authorised capital amounting to £1,284,000, as against sixty companies in 1909, with an aggregate authorised capital of £4,250,000. Most of the flotations in 1910 were of small importance, and of the total authorised capital raised, three companies —the Gresham Fire and Accident, the Royal London Auxiliary, and the London County Commercial—were responsible for £1,250,000, or about 97 per cent. of the whole.

NOTES ON BOOKS.

THE DEVELOPMENT OF THE TELEPHONE IN EUROPE. By Herbert Laws Webb. London: Electrical Press, Ltd.

Mr. Webb has republished in book form a series of articles on this subject which appeared last year in *Electrical Industries*, and has prefixed to them a short introduction by Mr. Harold Cox. Mr. Cox states briefly, but forcibly, the arguments against the purchase and working of telegraphs by the State, and shows that a commercial undertaking, which in other countries, notably in the United States, has paid handsome dividends, and one which, while in private hands in this country, was being developed economically and profitably, has not only failed to provide revenue, but has proved a source of considerable expenditure to the State.

Mr. Webb himself gives a very full account of the origin, evolution, and development of the telephone. While he draws very unfavourable conclusions as to the comparative results achieved

in America and this country, he also shows that Great Britain is not really much behind other European countries, which have suffered more or less from the same causes as those which have prevented the complete development of the telephone in this country.

The Arts and Crafts of Our Teutonic Forefathers. By G. Baldwin Brown, M.A. London: T. N. Foulis.

The substance of this book was delivered as a course of Rhind Lectures before the Society of Antiquaries of Scotland last year. Professor Brown's object is to prove that there is a genuine and original Teutonic art born and developed amongst the different branches of the Teutonic race, Goths, Burgundians, Franks, Angles, Saxons, Lombards, etc., and that it was not in any way due to Roman influence. This thesis he supports by an examination of the various works of art of Teutonic origin which have come down to our own times. The bulk of these are personal ornaments, or arms and armour, derived from graves, together with sepulchral urns, etc. There are also a few objects which have been preserved in churches and elsewhere, and still fewer monuments.

The book is illustrated with a very large number of photographs, but they suffer from their very small size, and their reproduction leaves something to be desired.

GENERAL NOTES.

Departmental Committees on Lead Poisoning amongst Painters.—The Home Secretary has appointed two departmental committees to investigate the danger attendant on the use of lead paints and compounds to persons engaged in painting buildings and to persons engaged in painting carriages and coaches. The chairman of both committees is Sir Ernest Hatch, Bart.; Sir Godfrey Baring, Bart., Lord Henry Bentinck, M.P., and Mr. E. L. Collis, Medical Inspector of Factories, are members of both committees. The other members of the committee on the painting of buildings are:—Mr. F. G. Rice, President of the London Master Builders' Association and Representative of the National Federation of Building Trade Employers; Mr. W. G. Sutherland, Secretary of the National Association of Master Painters and Decorators; Mr. Archibald Gardner, Secretary of the Scottish Society of House and Ship Painters; Mr. J. Parsonage, Secretary of the National Amalgamated Society of Operative House and Ship Painters and Decorators; and of the committee on the painting of carriages and coaches, Mr. A. L. C. Fell, Chief Officer of the London County Council Tramways; Mr. C. L. Mason, Works Manager of the London and North-Western Railway Company's works at Wolverton; Mr. Charles Kinggate, Secretary of the United Kingdom Society of Coach Makers; Mr. W. Robins, Member of the United Kingdom Society of Coach Makers. Communications may be addressed to the chairman at the Home Office.

Turin International Exhibition, 1911.—In the British Section of the approaching Turin Exhibition, chemical and physical apparatus will be shown, as far as possible, as it would be used in a laboratory. There will be on view at least two well-equipped chemical laboratories, with such work going on as will effectively illustrate various interesting processes. There will also be a large space available for the display in show-cases of chemical products and apparatus not in use in the laboratories, and smaller rooms will be provided for certain special appliances. The court devoted to scientific instruments will be of similar design. Here, also, arrangements are being made for the display of apparatus ready for work, electric supply, where needed, being provided. The equipment of a large dark room is under consideration, and in this, projection apparatus, such as oscillographs, spectroscopes, optical lanterns and photometers, could be shown to advantage.

Abnormal Places in Mines. — The Miners' Federation of Great Britain recently convened a national conference in London to consider the question of "abnormal places" in mines. In many districts throughout the kingdom miners complain of the existence of these abnormal places. By this they mean working places where the coal-getting is rendered difficult and unprofitable by reason mainly of the large proportion of refuse that has to be cleared away. It is obvious that where men are paid so much per ton of coal, every hour taken up with clearing refuse is, from their point of view, an hour wasted. For this reason special price-lists are struck for working such places, and the adjustment of price to place often leads to friction between employers and employed. The question formed one of the points in dispute when the Conciliation Board Agreement was being drafted in South Wales last spring, and it was found to be so difficult to adjust that it was agreed to leave it in abeyance and exclude it from the provisions of the Agreement. It was the friction concerning the price-list for working the Bute seam in some of the Rhondda Valley pits that led to the strike of the 12,000 men of the Cambrian Combine.

A New Mexican Fibre.—The discovery of a henequen plant in Chiapas, equalling, if not surpassing, that grown in any henequen-producing country, has been reported in Mexico. The leaf of the new plant is from five to six feet in length in its full growth. The fibre after examination, as compared with the Yucatan leaf, has proved itself superior in its tensile properties, colour and natural length of fibre. The plant in question is not the plant lately discovered near Tuxtla

Gutierrez, and named "non plus ultra" by its discoverer, Espatoline Moguel, who claims to have found it in a village not far from that place. Present indications are that it will not be many years before the State of Chiapas will be one of the foremost henequen producing districts of Mexico, and that it will be able to grow the plant at prices which will compete with the Yucatan product. The valley of Zintalapa is particularly suited to the cultivation of henequen. In this valley there are large plantations producing henequen of an average quality, most of which are fairly successful from a financial point of view. The United States Consul at Tapachula says that it is apparent that the plants and mechanical equipment for working the henequen are run in primitive fashion, and that anyone taking the matter up seriously could be assured of a financial success. Labour in Chiapas is more than plentiful, and low in cost; and properties having perfect titles are obtainable at comparatively low figures. Not only is there a profitable field in Chiapas for the cultivation of the plant, but there is also a field for the introduction of henequen machinery.

Rubber Auctions in Ceylon.—On November 4th, 1910, the first rubber auction was held in Ceylon. A quarter of a century ago—and well within the memory of many colonists still resident and retired—the first public sale of tea was held in Colombo, and those who have witnessed the development of the tea sale will not be inclined to minimise the importance of the opening of the rubber auctions. The quantity offered at the first sale was twenty-two tons. The chief factor which has led to the inauguration of the rubber sales is the convenient position of Colombo in relation to the large consuming countries. Buyers in these countries already find it convenient to come direct to Colombo for their supplies. Public sales of rubber will be conducted weekly, it is said by the American Consul at Colombo, and it is anticipated that the new departure will meet with the same success as has attended the tea auctions. There are at present 12,000 bearing acres of rubber in Ceylon, while 185,000 acres have been planted. It has been estimated that 220,000 acres will be the maximum area planted with rubber in Ceylon, and that with 140 trees to the acre and one pound and a-half yield per annum, this will give an export of 20,000 tons by 1920. The 1909 exports amounted to 681 tons.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

February 15.—George A. Stephen, "Modern Machine Book-binding." John Murray, J.P., D.L., F.S.A., will preside.

February 22.—Professor J. Wertheimer, B.Sc., B.A., "Water-Finders."

March 1.—Dr. Leonard Hill, F.R.S., "Caisson Sickness and Compressed Air."

March 8.—James Cantlie, M.A., M.B., C.M., D.P.H., "Plague and its Dissemination." Sir Shirley Forster Murphy, M.R.C.S., will preside.

Wednesday afternoon, at 4.30 o'clock:—

March 15.—Colonel Charles Edward Cassal, V.D., F.I.C., "The Adulteration of Food." The Right Hon. the Lord Mayor of London will preside.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

March 16.—Claude Hamilton Archer Hill, I.C.S., C.S.I., C.I.E., "Education in India."

April 27.—Sir Thomas Henry Holland, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India." Lord Avebury, D.C.L., LL.D., F.R.S., will preside.

May 25.—W. R. H. Merk, I.C.S., C.S.I., LL.D. "The N.W.F. Province of India."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

February 28.—The Hon. Sir Richard Solomon, K.C.B., K.C.M.G., K.C.V.O., K.C., M.A., High Commissioner for the Union of South Africa, "The Resources and Problems of the Union of South Africa."

April 4.—Captain R. Muirhead Collins, C.M.G., "Australia and her Resources."

May 9.—F. Williams Taylor, "Canadian Banking."

Cantor Lectures.

Monday Evenings, at 8 o'clock:—

Professor Adrian J. Brown, M.Sc., "Brewing and Modern Science." Four Lectures.

Syllabus.

Lecture II.—February 13. — "Malting." Constitution of the Barleycorn — Character of Changes during Germination—Investigations of the Biochemistry of Germination—The Barleycorn a highly-specialised seed, etc.

Lecture III.—February 20.—"The Mashing Process." The Chemistry of Starch and its Transformation Products—Protein Changes during the Mashing Process.

Lecture IV.—February 27.—"The Fermentation Process." Previous Treatment of the subject by Dr. G. Salamon in 1888—The Pure Yeast Question in Brewing—Zymase and Modern Views of Alcoholic Fermentation—Nitrogen Assimilation—The so-called "secondary" products of Fermentation, etc.—Conclusion.

Professor J. A. FLEMING, M.A., D.Sc., F.R.S., "Applications of Electric Heating." Four Lectures.

March 6, 13, 20, 27.

ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

May 1, 8, 15, 22.

Dates to be hereafter announced:—

FRANK M. ANDREWS, "Architecture in America."

ARTHUR CHARLES DAVIS, F.C.S., Assoc.Inst.C.E., "The Manufacture and Testing of Portland Cement."

CYRIL DAVENPORT, "Illuminated Manuscripts."

GEORGE B. HEMING, "Art Education in Jewellery and Goldsmithing."

Professor RAOUL PICTET, "Les Basses Températures."

Sir WILLIAM ABNEY, K.C.B., D.C.L., D.Sc., F.R.S., "The Quantitative Measurement of Colour-Blindness."

HAL WILLIAMS, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

NOEL HEATON, B.Sc., F.C.S., "The Production and Identification of Artificial Gems."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 13...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor Adrian J. Brown, "Brewing and Modern Science." (Lecture II.)

Brewing, Institute of (London Section), Criterion Restaurant, Piccadilly, W., 8 p.m. Mr. G. Cecil Jones, "The Purchase of Fuel on Specifications."

Surveyors, 12, Great George-street, S.W., 7 p.m. (Junior Meeting.) Mr. G. G. Symons, "Land Banks and Co-operative Credit Societies."

Geographical, Burlington-gardens, W., 8.30 p.m. Major P. H. Fawcett, "Further Explorations in Bolivia."

British Architects, 9, Conduit-street, W., 8 p.m. Messrs. P. Waterhouse, J. W. Simpson, and E. A. Rickards, "The Artistic Development of London."

Mechanical Engineers, Storey's Gate, Westminster, S.W., 8 p.m. (Graduates' Lecture.) Captain H. R. Sankey, "Wireless Telegraphy."

TUESDAY, FEBRUARY 14... Aeronautical, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. 1. Mr. F. H. Page, "The Pressure on Planes and Curves." 2. Professor G. H. Bryan, "A Note on the Turning Movement of Aeroplanes."

Asiatic, 22, Albemarle-street, W., 4 p.m. Sir Charles J. Lyall, "'Abid of Asad, an ancient Arabian Poet,' with some specimens of translation."

Royal Institution, Albemarle-street, W., 3 p.m. Professor F. W. Mott, "Heredity." (Lecture V.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Mr. W. J. Wilgus' paper, "The Detroit River Tunnel, between Detroit, Michigan, and Windsor, Canada." 2. Mr. W. T. Douglass, "Coast-Erosion."

Photographic, 35, Russell-square, W.C., 8 p.m. Annual General Meeting.

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. Mr. Ellis T. Powell, "The Industrial Development of Canada."

WEDNESDAY, FEBRUARY 15...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. G. A. Stephen, "Modern Machine Bookbinding."

Meteorological, 25, Great George-street, S.W., 7.30 p.m. 1. Messrs. R. Cooke and S. C. Russell, "Variation of the Depth of Water in a Well at Detling, Maidstone, compared with the Rainfall, 1885-1909." 2. Mr. A. W. Clayden, "The Actinograph; an Instrument for recording changes in Radiation." 3. Mr. K. M. Clark, "New Cloudiness Charts for the United States."

Automobile Engineers, at the Institution of Mechanical Engineers, Storey's Gate, S.W., 8 p.m. 1. "Report of the Horse-Power Formula Committee," with a Note by Mr. Dugald Clerk. 2. Mr. G. A. Burls, "A Proposal for a Maximum Power Rating Formula."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. E. M. Nelson, "On some New Objectives and Eye-Pieces by R. Winkel, of Göttingen." 2. Messrs. Edward Heron-Allen and Arthur Earland, "On the Recent and Fossil Foraminifera of the Shore-sands of Selsey Bill, Sussex. Addendum."

United Service Institution, Whitehall, S.W., 3 p.m. Major C. D. Simonds, "With the Anglo-French Niger-Chad Boundary Commission."

THURSDAY, FEBRUARY 16...Illuminating Engineers, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Discussion on School Lighting, with papers by Dr. J. Kerr and Dr. N. Bishop Harman.

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Linnean, Burlington House, W., 8 p.m.

Geographical, 1, Savile-row, W., 5 p.m. Professor Edgeworth David, "Some Antarctic Problems."

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. H. Davies and F. S. Kipping, "Different Methods of Applying the Grignard Reagents." 2. Messrs. F. B. Thole and J. F. Thorpe, "The Formation and Reactions of Imino Compounds. Part XV. The Production of Imino Derivatives of Piperidine leading to the Formation of the $\beta\beta$-ol-substituted Glutaric Acids." 3. Messrs. E. H. Rennie and W. T. Cooke, "The Interaction of Copper and Nitric Acid in Presence of Metallic Nitrates. Part II."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. P. Chalmers Mitchell, "Problems of Animals in Captivity." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Dr. S. Nathan, "History of Three Centuries told by Roman Coins."

Philatelic, 4, Southampton-row, W.C., 6 p.m. "Notes on the Stamps of Roumania."

FRIDAY, FEBRUARY 17... Royal Institution, Albemarle-street, W., 9 p.m. Professor H. E. Armstrong, "The Stimulation of Digestive Activity."

Engineers, Junior Institution of, at the United Service Institution, Whitehall, S.W., 7.30 p.m. Mr. B. Bylander, "The Architectural and Engineering Features of the Royal Automobile Club Building."

Geological, Burlington House, W., 3 p.m. Annual General Meeting.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. James Swinburne, "The Uses of Chemistry in Engineering." (Lecture I.)

Mechanical Engineers, Storey's Gate, Westminster, S.W., 8 p.m. Discussion on Messrs. W. Dixon and G. H. Baxter's paper, "Modern Electrical Dock-Equipment, with Special Reference to Electrically-Operated Coal-Hoists."

SATURDAY, FEBRUARY 18...Royal Institution, Albemarle-street, W., 3 p.m. Mr. T. G. Jackson, "Architecture: The Byzantine and Romanesque Period." (Lecture II.)

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FRIDAY, FEBRUARY 17, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

PRESIDENCY OF THE SOCIETY.

The Council have the gratification of announcing that, with the approval of His Majesty and the consent of His Royal Highness, they elected, at their meeting on Monday, the 13th inst., His Royal Highness the Duke of Connaught, K.G., as President of the Society.

The Council also passed a cordial vote of thanks to the Lord Chief Justice, who has held the office of President since it was vacated by His Majesty, and who resigned in order to make way for His Royal Highness the Duke of Connaught.

NEXT WEEK.

MONDAY, FEBRUARY 20th, 8 p.m. (Cantor Lecture.) Professor ADRIAN J. BROWN, M.Sc., "Brewing and Modern Science." (Lecture III.)

WEDNESDAY, FEBRUARY 22nd, 8 p.m. (Ordinary Meeting.) Professor J. WERTHEIMER, B.Sc., B.A., "Water-Finders."

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURES ON "BREWING."

On Monday Evening, the 13th inst., Professor ADRIAN J. BROWN, M.Sc., delivered the second lecture of his course on "Brewing and Modern Science."

The lectures will be published in the *Journal* during the summer recess.

COVERS FOR JOURNALS.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1*s*. 6*d*. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A Meeting of the Colonial Section was held on Tuesday, January 31st, Sir WILLIAM HOOD TREACHER, K.C.M.G., presiding.

The CHAIRMAN, in opening the meeting, explained that the paper to be read was one of a series which was being given under the auspices of the Colonial Section of the Society on the "Commercial Products of the Empire." It was hoped that the series of papers would help people to realise that our world-wide Empire contained within its bounds, extending as it did through all the zones, all the raw products necessary and essential for the support and welfare of its people.

The first paper of the series dealt with the subject of Wheat, and was contributed by Mr. A. E. Humphries. The second paper was written by the Agent-General for Tasmania, and had for its subject Fruit, and the third paper was the one about to be read, dealing with the Tin Resources of the Empire, by Mr. Douglas Osborne, a member of the Legislative Council of the Malay States. The author's lot and his own were for several years cast together in the Malay Peninsula, which was one of the most successful instances of the art of British government in the way of "Protectorates." It was a country teeming with tin-ore deposits, and at one time produced more than two-thirds of the tin supplies of the world. In that country his (the Chairman's) lot was on the humdrum side of the Government public service, while the author's was on the more exciting and more lucrative side of tin mining.

The Paper read was—

THE TIN RESOURCES OF THE EMPIRE.

By F. DOUGLAS OSBORNE, M.INST.M.M.

To the average man "Tin" means but little, and, if thought of at all, is vaguely associated with pots and pans; but in reality tin is one of the most interesting of the metals, and the fact that some 100,000 tons of it are consumed annually in the arts and industries proves that

it is of considerable importance to the world at large.

Tin is a white metal with a silver-like lustre, which remains untarnished for a long time when exposed to the atmosphere. It is very soft, so soft that it can be scratched or indented by a finger nail; it is ductile and tough to such an extent that it can be beaten out to resemble paper, a form in which it is familiar to most people as a wrapper of chocolates and other sweetmeats. It is a metal which, when once used, is rarely recoverable, and, therefore, is a wasting commodity, so that unless some substitute is found, the consumption of tin must increase as the world's trade expands.

In "The Production of Tin," published by the *Mining Journal*, Professor Lewis wrote :—

"Tin occupies in many respects a unique position amongst the various metals used in the arts, due not only to its specific properties, but to an even greater extent to its mode of distribution and occurrence.

"In the first place, it is the rarest of common metals of commerce, and is produced in markedly smaller quantities. Unlike most of these metals, it is distributed sparingly throughout the world, occurring in workable amounts at but few localities; where it does occur, however, it is generally, but not invariably, found in very important quantities. Again, tin is the only common metal, except iron, the only true ore of which consists of an oxide of the metal. All the other minerals appear to have been deposited originally as sulphides, their existence in the oxidised state being due to the secondary action of atmospheric agencies upon these sulphides. Hence the other metals are found as oxides near the outcrop only of their deposits, but as sulphides in depths, while tin appears as an oxide wherever it has hitherto been found, even in the deepest mines in which it has been met with, and at depths where all other metals are known only as sulphides.

"Again, the sulphides of the other ordinary metals, when exposed to atmospheric agencies, form more or less soluble compounds; oxide of tin is notable for its great chemical indifference and for its insolubility in those reagents that dissolve most other metallic compounds. Hence the degradation of a mineral deposit containing any of the other metals is apt to be accompanied by the removal in a state of solution of those other metals.

"In the case of tin it will only lead to a concentration and purification of the oxide. This is why oxide of tin (the tinstone or black tin of the miner and cassiterite of the mineralogist) is found to so large an extent in alluvial gravels, a mode of occurrence that it shares almost exclusively amongst metallic minerals with those other chemically indifferent substances, gold and platinum."

To this property the world owes its abundant supply of the metal, for by far the greater portion of tin produced comes from alluvial deposits, and again its indifference to the action of acids is responsible for its use in the tin plate trade, by which over 25,000 tons are annually absorbed. In this trade its function is to coat steel plates so that these can be converted into receptacles for all manner of things; preserving the steel plates from oxidisation, which would quickly render them porous, it admits of much thinner steel being used and keeps the contents pure and untainted.

Other uses for tin are many. It is familiar to most people in the form of solder, and enters largely into the composition of brass, gun-metal, bell-metal and phosphor bronze.

As "white metal" it is used for type metal, pewter, machine bearings and valve packing, bottle capsules, fusible alloys, electric fuse wire, Britannia metal, tea lead, the foundation for gold and silver plating, and the manufacture of toys.

Tinfoil is pure tin.

Cheap reflectors are tinned instead of being silver plated.

In dyeing and calico printing it is used as stannous chloride, for the precipitation of colours.

Bronze powder used for decorative purposes, and having a golden lustre, is the bisulphide of tin.

Pure block tin is largely used by Chinese for the manufacture of ornamental vessels, the soft nature of the metal rendering it particularly adaptable to the characteristic scroll work of the Chinese.

That tin was known and used in the early ages there is abundant evidence.

Egyptian bronzes of the eighteenth dynasty and coins of 30 B.C. in bronze contain tin, and the commencement of the Phœnician trade with Cornwall for tin is generally assumed to have taken place about 1200 B.C. Ancient bronze weapons and tools invariably have had tin added for the sake of hardness.

The chief sources of the world's tin supply are the Malay Peninsula and the Islands of Banca and Billiton; Bolivia; Australia and Tasmania; Cornwall; South Africa; Nigeria

and Swaziland; China. It is also produced in New Zealand, Burma, the Congo Free State, Korea, Japan, Spain, Portugal, Central Europe, France and Alaska, but not in quantities that are of any importance.

THE FEDERATED MALAY STRAITS.

Of the sources named, the Malay Peninsula is the most important, as from thence comes more than half of the total supply.

Situated at the south-eastern extremity of the continent of Asia, the Peninsula consists of a narrow strip of land varying in width from less than 50 to nearly 200 miles, and extending from latitude 13° 30′ N. to 1° 18′ N. The northern part of the Peninsula is feudatory to Siam, and in this part the development of the mineral resources has hardly begun. Towards the south are the Federated Malay States, which, under British protection, have so wonderfully developed during the past thirty years. It is from these States, Perak, Selangor, Negri Sembilan and Pahang, that the major part of "Straits Tin" comes. In 1909 the amount exported was little short of 49,000 tons.

That mining for tin in these States has been going on for long years, there is evidence in the form of old workings all through the country; but it was not until the advent of the Chinese that any considerable quantity was produced, and only since their faction fights, which led to British interference and subsequent protection, that the States have rapidly developed and become the mainstay of the world's tin supply.

The tin exported from the Federated Malay States is almost entirely won from alluvial deposits. The most important of these are in Perak and Selangor, the former being at present responsible for about 56 per cent. of the total.

In the Federated Malay States during the twenty years 1890 to 1909, there has been produced 873,703 tons of tin, or an average of 43,685 tons yearly. Of this total Perak produced 447,900 tons; Selangor, 329,564 tons; Negri Sembilan, 73,315 tons; and Pahang, 22,924 tons.

The maximum production was in 1905, when the output for the States reached a total of 50,991 tons. Since then the production has diminished slightly; 48,743 tons were produced in 1909, and it appears as if there will be a greater falling off during 1910 (total 45,000). Almost the whole of this production comes from alluvial workings, as at present, with the exception of the mines of the Pahang Consolidated in Pahang, and some workings in the Kledang range of hills near Ipoh in Perak, no lode mining is carried on, and the total production from these two sources does not exceed 1,200 tons per annum. The chief centres of the alluvial workings are the Kinta Valley in Perak and the flats near Kwala Lumpor in Selangor drained by the Selangor and Klang Rivers. In these places it is hardly an exaggeration to say that tin occurs everywhere, from the surface of the ground down to depths of 250 feet, on the flat land, in the valleys, and high up on the mountains.

The Kinta Valley, which is so enormously rich in tin and which is typical of the characteristic deposits, is the valley drained by the Kinta River, the most important tributary of the Perak, with which it runs parallel in a southerly direction, the Kledang range forming the watershed between the two rivers and the boundary of the Kinta Valley on the west; on the east of the valley is the main range of the Peninsula. The valley is about thirty miles long by twelve wide and is very flat, the mountains on each side rising abruptly. Mining villages, well laid out and tidy, are scattered throughout, connected by well-made cart roads, and the main railway runs through the centre. The chief geological features of the valley may be described as a floor of highly crystalline limestone or marble, usually white in colour, and lying in the centre of the granite mountains. On the east side this limestone forms a series of wonderful pinnacles or hills, rising in cases as high as 2,000 feet above the surrounding country, covered by dense jungle scrub, and honeycombed by caves and fissures. It has been weathered to a very irregular surface, forming innumerable small pinnacles and crevices, is non-fossiliferous and its geological age is unknown. The mountains on either side are composed of intrusive granite, which has doubtless been the cause of the upheaval and contortion of the limestone, the intrusion of the granite having probably occurred simultaneously on both sides of the valley, and thereby squeezed the limestone into the extraordinary shapes which it has assumed.

The tin deposits are extremely irregular and follow no well defined lead. The richest occur in the vicinity of the granite foothills, much tin being occasionally concentrated in the fissures left at the junction of the granite and limestone, as in the case of Tronoh and Lahat. The channels and crevices in the limestone valley bed invariably are rich in tin, and it is from these shallow deposits that the majority of the tin is won by the Chinese workers. The

tin wash may be sandy or heavy clay; it may occur in layers separated by barren ground, or the whole of the ground from surface to bed-rock may carry tin; and as in the valley the holes and crevices in the limestone are filled with tin-bearing ground, so it is in the hills, even up to heights of 1,200 and 1,300 feet. Isolated deposits from time to time are found in the limestone, the most notable of these being the Tambun Mine, from which in 1903 as much as 350 tons of tin ore was won during one month, and the average for the year was some 250 tons per month. There being no connection between this deposit and any other of considerable value makes it all the more difficult to evolve a reasonable theory as to the origin of the mineral, more especially as, in the case of Tambun, the tin is much less water-worn than is the case in many of the cave deposits in the hills, which are much closer to the granite ranges, from the weathering of which the alluvial tin was most probably derived.

Mr. Scrivenor, the Government geologist, is of the opinion that it is much more probable that the bulk of the alluvial tin has been derived from the masses of pegmatite, lodes, and stockwerks which take part in the formation of the low rolling country at the foot of the high ranges, than that it was derived from the high granite mountains.

In his report for 1904 he states that undoubtedly the bulk of the tin found in the Tronoh mine had its source in the hill lying to the west of the mine.

If this theory is accepted, it becomes still more difficult to account for the presence of alluvial deposits high up in the limestone caves and on the mountains. My opinion is that the bulk of the tin deposits of the Federated Malay States came from the weathering and erosion of lodes that existed in the granites and schists. Even close to the foothills the tin deposits are almost invariably much waterworn and rounded, which naturally leads to the conclusion that they have travelled a considerable distance. Then, if the tin came from high granite hills, it is a simple matter to account for its presence in the high caves and fissures of the limestone cliffs, for where the granite pushed through and distorted the limestone, huge crevices are left which would catch the detritus subsequently washed down from above, and, acting as receptacles for large bodies of water, hydraulic power would be provided, capable of forcing the alluvium through channels in the limestone and to considerable heights.

Wherever the tin came from, however, there is no doubt that the greater portion found its resting-place on the west of the main range. These on the west side are almost continuous from Taipeng to the north to Seremban to the south, and an interesting feature is that their extent and value seem to diminish towards the south. From this it might be deduced that the main source of the supply was the mountains of Perak. On the east coast the tin-fields are less numerous, more scattered; the deposits are of a more recent period, and, as the bedrock of the alluvial workings is generally granite rock, there seems but little likelihood of discoveries being made of new fields which will equal in richness those on the west coast.

It is probable, however, that lodes of considerable importance may in time be discovered and worked in the eastern States.

For the development, in the future, of the tin resources of the Federated Malay States there is no doubt that modern machinery and abundant capital are necessary. The shallower, richer and easier-won deposits having become exhausted, those remaining require, for their development, modern engineering skill and plant capable of treating large quantities economically.

The methods by which alluvial deposits are worked may be described under four heads:—

Ground sluicing, with its modern development of hydraulicking.

Open cast workings.

Underground workings.

Dredging.

Ground sluicing is only practicable where a sufficiency of water is available and an outlet for the debris exists. It is a favourite form of mining for small parties, little capital being required. The scene of this class of operations is, generally speaking, some narrow valley up in the hills. A watercourse is cut to the face that is to be worked, and along the face a narrow channel or ground sluice, with sufficient slope to enable the valueless dirt to be carried off by the water, while the tin remains behind. The ground is then, as soon as water is turned on, hoed from the face into the sluice, and kept stirred until it is considered that sufficient has been run in, when the hoeing is stopped, and the dirt in the sluice is kept stirred until the lighter material has nearly all been carried away, and but little except tinstone remains.

Hydraulicking is but a modern development of ground sluicing, water being used to do the work. Being brought to the ground in pipes and subject to considerable pressure, the water

is directed by means of swivelling directing nozzles, known as "giants" or "monitors," against the face to be worked. This is gradually undercut at the lowest possible level, until a huge mass of ground falls down. The jet is then played on this until the whole is disintegrated and carried away into the sluices, when a recommencement is made to get down a fresh fall. In this manner very large quantities of ground are removed and treated, and naturally must find a fresh resting-place. To a certain extent this necessity is provided for by the valleys below the hydraulic mines, which are mostly hills; but as time goes on, even these become filled, and then the water-power is again called upon for assistance. By its help the debris from the ends of the sluices is elevated and stacked. These hydraulic jet elevators, as they are called, are wonderfully simple and efficient. They consist of an uptake pipe set at an angle of about 20° from vertical, having at the lower end a bell-mouthed intake, below which is set a nozzle supplying the power. All sand, water, and stones coming to the end of the sluice are caught by the force of this nozzle, shot up through the uptake pipe to a height proportionate to the requirements of the case and pressure available, and thereby the difficulty of getting rid of tailings has been overcome.

The tinstone, being heavier than the dirt containing it, travels more slowly in the sluices, and tends to gravitate to the bottom, advantage being taken of this fact to save it. For this purpose various types of sluices are used. The most primitive, and, it is maintained by the managers of the leading group of hydraulic mines, the most efficient and economical, are simple sluices cut in the bedrock, which, left to themselves, are periodically cleaned up by women working with flat circular dishes. Wooden sluices with and without riffles, or stops, are also used; but these require more water and, when riffles are employed, constant attention and stirring, which tends to keep the tinstone moving and to consequent loss.

The cost of working on a well-managed hydraulic mine is very low, being less than 1*d.* per cubic yard; but as water has generally to be brought a considerable distance in pipes and ditches, the initial outlay, before working starts, is generally heavy.

By far the greatest part of tin-mining in the Federated Malay States is carried on by open cast mining. It is a method of mining introduced and developed by the Chinese—in plain English, it consists of digging a large hole in the ground and extracting from its contents all that is of value. Where the scene of operations is on a well-defined lead of tin-bearing gravel, works of an extensive nature and some measure of permanency are undertaken; otherwise luck is largely trusted in, and too often with disastrous results.

The site for opening a mine having been chosen, and the jungle felled and cleared, a strong earthen embankment is built round, so as to prevent an inrush of flood water. Sheds for the accommodation of coolies are erected, and the necessary watercourse cut, to provide water for separating the tinstone from the gravel.

All being ready, a commencement is made to remove the "overburthen" or barren ground overlying the stanniferous alluvium. This work is always done by contract, the overburthen from the first paddock being stacked round the excavation. When the "karang," or tin-bearing gravel, has been uncovered, it is lifted by wages coolies to the wash-boxes, for the separation of the tin from the gravel. These wash-boxes are of coffin shape, varying in length from 10 to 30 feet, and are set at a grade of about 1 in 12. They are about 3 feet to 3 feet 6 inches at the widest part, where the tin is saved, and gradually narrow towards the end to from 10 to 18 inches.

At the widest part a baffle board is fixed, about 8 to 12 inches deep, over which a portion of the water used falls, and at the side on which the karang is deposited, a square aperture is cut, through which a stream of water constantly flows, carrying the karang, which is stirred by a coolie with a rake, into the box, where it is immediately caught up by the washers, working with large long-handled hoes, drawn against the stream, turned over and over and tossed, until it is considered that the box will not, with safety, hold any more tin. Then the stream through the side is shut off, and the tinstone, after a little further washing, lifted and put into tubs or baskets for transport to the store.

The first paddock having been exhausted of karang, it becomes the dumping ground for the overburthen which has to be removed from the second, and so the operations continue until the ground is all worked out.

To contend with the seepage water, centrifugal pumps, operated by portable steam-engines, are now almost invariably used; but before the introduction of these, the Chinese chain pump, driven by water-power, was the

only pump used, and in many places these are still in vogue, sometimes worked by a steam-engine, sometimes by coolies, treadmill fashion, but more often by water.

By the style of open cast mining described, depths of 65 feet were worked, but deposits deeper than that were generally left alone until mechanical haulage was introduced. Now mines of a depth of 100 feet and over are by no means uncommon.

Various systems of haulage and for the excavation of the ground have been tried, such as steam shovels and grabs, blondins, belt-conveyers, endless rope-ways, and Kimberley gears, but the system that has proved the most efficient and economical is inclined tramways, with trucks which are filled on contract rates by coolies, both Chinese and Indian.

The irregularity of the run of tin-bearing ground militates against the success of fixed mechanical haulage, whereas branches from the tram lines can be run in all directions, and the, generally speaking, heavy clayey nature of the deeper deposits renders the use of steam shovels and grabs unprofitable as compared with coolie hoe work. The former sends up to the dressing-plant large masses of hard clay lumps and stones, which have to be broken up before treatment, whereas the hoe work breaks all up and reduces the mass to a condition most favourable for treatment.

The ground excavated is sent first to the puddling plant for disintegration, the plant most generally adopted being in the form of iron vats about 30 feet in diameter by from 3 to 4 feet deep. The dirt for treatment is fed into these with a constant stream of water. There are four horizontal arms radiating from a power-driven spindle situated in the centre of the vat, and to these arms are fastened by chains heavy harrows, which gradually reduce the mass, the clayey part being floated away by water, and the heavier sand, stones, and tin remaining in the bottom of the vat until a charge is completed, when it is let out for final dressing in wash-boxes. In some installations there is a constant discharge from the puddles into long sluice boxes, the bottoms of which are armed with riffles, or stops, placed across the box at intervals of 1 to 3 inches. The puddled dirt and water travelling in these boxes is kept constantly stirred by men raking between the riffles at right angles to the flow, and the tin is deposited between the riffles. Experience, however, shows that this system is wasteful of tin as compared with concentration in the puddling vat. Horizontal puddlers, consisting of a box some 10 feet in length, with a central shaft armed with knives revolving at a high speed, are also used.

Underground working is confined to those deposits where the amount of overburthen is too great to admit of the proposition being worked open cast. It is often adopted by small parties working on tribute, in order to avoid the capital outlay necessary to open a mine.

The method of working is to sink a number of shafts at regular intervals, the extent of which depends on the nature of the ground to be dealt with. Through the shafts the "karang," or pay dirt, is brought to the surface for treatment, and the whole is thus gradually blocked out as the various shafts are connected below.

By this method depths of 250 feet have been reached, and where the tin bed is deep, of little thickness and width, this is the only way by which it could be mined; but generally it is not economical, for though the cost of removing overburthen is avoided, the expense of timbering the shafts and drives adds so much to the outlay on excavation that, in most cases, the price at which the karang is raised exceeds considerably what would have been necessary if the proposition had been dealt with by open cast. As a consequence, much ground which is rich in tin is left untouched, owing to there not being quite sufficient tin to pay for its excavation and the necessary timbering, in addition to which there are usually layers of karang above the main layer which are left untouched, and which in an open cast mine would have been taken advantage of to reduce the cost of stripping.

There are many instances to prove that the values left in underground mining are considerable, mines after having been worked as far as they could profitably be dealt with by this method having been open cast and paid handsomely. One instance is the Tambun Mine, before referred to, which was worked to the limit admissible by shafting, and is now a highly profitable concern, worked as an open cast mine. In fact, as regards Chinese-run underground workings, it may be taken that only the richest portions are touched, and the system must, as already stated, be regarded as wasteful, and, therefore, should not be encouraged.

Dredging is of two forms—bucket dredging and dredging by means of centrifugal gravel pumps. No bucket dredging has so far been attempted in the Federated Malay States,

though the use of bucket dredges for the recovery of gold and tin from river beds and flats is general in Australia and New Zealand. A bucket dredge is nothing more nor less than the ordinary dredger, slightly modified, which most people have seen clearing away accumulations of mud and sand from harbours. In mining use, instead of being shot into a hopper at the side, the dirt raised by the buckets is dumped into a revolving trommel, from the centre of which strong jets of water are playing, which disintegrate the lumps, allowing the smaller particles to pass through the perforations in the trommel plates on to tables or other value-saving appliances, the valueless debris passing out over the end of the pontoon, and, where necessary, being elevated and stacked by another system of buckets. The great advantage of dredging lies in the large quantities of ground that can be treated at a very low cost.

Dredging by centrifugal pumps is a modern adaptation of the principle of hydraulic mining, and was first introduced in Australia. Essentially it is hydraulicking at a low level, the difficulty of getting rid of the tailings being met by the introduction of a centrifugal pump, which raises them to a height at which they will find an outlet by gravitation.

The plant is carried on a strong pontoon, and consists of the power in the shape of engines and boilers, or electric motors, the gravel pump, electric lighting plant, and, where natural gravitation does not supply sufficient pressure, the nozzle pump to force water through monitors to break down and disintegrate the ground.

The ground is undercut in the manner already described when dealing with hydraulic mining, and gravitates through a channel cut in the bedrock to the sump of the gravel pump, whence it is sucked up and delivered into a sluice box, in which the tin remains, while the sand and gravel is carried off by the water. Of course, in order to gravitate the dirt and water to the sump, the channels cut in the bedrock must rise higher and higher as the faces become more distant from the sump. When such a distance has been reached that it is no longer possible to gravitate the whole of the tin ground to the pump, the entire plant has to be brought closer to the face. This is done—after a bed for a pontoon has been prepared—by allowing water to flood the paddock and float the pontoon. The pontoon is then towed to the new site, and water is pumped out, the pontoon bedded down, and operations recommenced.

Ground to a depth of 150 feet has been worked in this way by a series of two lifts, and by a single lift a depth of 100 feet has been reached. Working costs are low, though the wear and tear on pumps is heavy, and renewals of wearing parts have frequently to be made.

For the future development of the tin resources of the Federated Malay States, plants of this description must be the mainstay if cheap power can be procured. Already it has been demonstrated practically that ground which has already been worked Chinese fashion, and abandoned as exhausted, can be worked profitably, and it needs only the introduction of some more economical means of generating power than is at present available, for the thousands of acres of so-called exhausted tin-fields to be profitably reworked. The substitution of suction gas for steam has already met with a considerable measure of success in the Sungei Raya Mine in Kinta, where the plant has been intelligently treated, and there is a scheme in prospect for generating electric energy by the water-power of the Kinta River. Should this scheme be carried to a successful issue, working costs, where its electric energy is employed, must be reduced to such a low figure that but little land in the Kinta Valley and other mining fields is too poor in tin not to be a payable proposition.

Given the means of systematically turning over the land that has already been worked, there is no doubt that many rich deposits, the existence of which is at present unthought of, will be discovered, and in this way the output of the Federated Malay States may be maintained at a high level for many years to come.

So far the alluvial resources only have been dealt with; but, in addition to these, there are the lodes to be developed, and in a country where such abnormally rich alluvium has been found, all of which at some period must have come from the decomposition or erosion of metalliferous veins in the rocks, it is but reasonable to presume that time and patience, with the assistance of capital, may discover the sources of the alluvial supplies and develop them into profitable tin-producing mines.

Already enterprise has begun to develop the lodes in Perak and Pahang. So far, in Pahang, the majority of the tin won has been found in the slate country, overlying the granite, none of the lodes having been followed through the slates into the granite.

The property of the Pahang Consolidated Company at Sungei Lembing (formerly owned

by the Pahang Corporation and the Pahang Kabang Co.), has been worked for over twenty years, and it is said that more than thirty lodes have been discovered, having an east to west course, the angle of dip varying from ten degrees to forty degrees, according to Mr. W. H. Derrick. The country in which the lodes have been worked is schist or slate overlying the granite. Mr. Scrivenor considers that the lodes here are fissure veins, and expresses the opinion that they will continue to great depth. Certainly the lodes can in some cases be traced into the granite, but the measure of success that has so far rewarded the liberal development policy of the Pahang Consolidated Co. is so small that an opinion as to the future value of the property cannot be formed.

Mr. Scrivenor and Mr. Sydney Fawns both consider the outlook promising. The latter, in his book, "Tin Deposits of the World," writes:—

"The lode at Bundi constitutes one of the best defined and richest lodes at present operating in the Malay Peninsula. Taking this lode in conjunction with the lodes at Sungei Lembing and other places in the Kuantan district, forty miles to the south, and the district of Sungei Ayam, twenty miles to the north, goes to prove that a large lode-mining centre exists in this part of the peninsula."

But at the Bundi Mine, again, the lode hitherto worked has been in the schists or at the contact of the schists and granite, the lode proper being entirely composed of chloritic schists.

The late Mr. Warnford Lock, however, in commenting on the Sungei Lembing lodes in his book, "Mining in Malaya for Gold and Tin," writes:—

"They never possess two distinct walls, and very rarely one. They appear rather as brecciated or 'mullocky' lodes, or as impregnations of the shattered country, and are most irregular in size, in proportion of lode matter to the total width, and in richness of contents in tin. Whether any *workable* lode will ever be traced into the granite is still quite uncertain. It has not been done yet; and in the only cases so far encountered where the lode can be seen at all in the subjacent granite mass, it is very small, in exceedingly tight ground, and barely stanniferous."

Mr. Lock's opinion of the Bundi Mine was not any better—in fact, he questions the existence of a lode at all.

Lodes rich in wolframite and tin have been worked in the Gopeng district of Kinta in the decomposed schists, but these invariably ceased at the contact of the schists with the granite, though in the schist country they were strong, varying in width from 18 inches to 3 feet and with well-defined walls.

In the Kledang range of hills, close to the village of Menglembu, in Kinta, a series of lodes have been discovered in the granite, and are at present being developed. The country rock is a hard granite. The general strike of the rock is N. 58° East, in which direction fissures occur, varying in width and at irregular intervals. These fissures are filled with mineral, cassiterite, arsenical and iron pyrites, and galena, cassiterite predominating, veins of it, almost pure, being in some cases as much as 5 inches thick. The stone intervening between the main fissures has also been enriched by the mineral permeating innumerable small veins which run in irregular courses from the main mineral bodies.

Unfortunately, the capital at the disposal of those interested in these lodes is quite inadequate, and development work cannot be pushed ahead.

The Menglembu property has two shafts extending in depth to 300 feet in granite, both of which have been sunk on the main lode. Levels driven at right angles to the strike of the rock have discovered parallel lodes of varying width. The main lode has been traced underground for a distance of 600 feet, and seems to have improved in value as greater depth was reached.

Assays taken at various parts of the workings gave irregular values, and the manager states that the stanniferous ore bodies occur in lenticular shape following a quartz vein which runs through the granite.

Chinese and other workings in these hills have disclosed the presence of many outcrops of lodes, all running parallel to those being worked at Menglembu, and there appears to be no doubt that there is here a mineral zone only waiting for sufficient capital to develop into a valuable source for tin.

In addition to the true lodes, of which there are indications, there are also the stanniferous pegmatites, which may form an important reserve to the tin resources of these States.

All through the States this rock occurs, and the Government geologist writes of it as "pegmatite *in situ* bearing tin ore disseminated through the mass, and also in small pockets and leaders," and that "it is possible that the pegmatite goes down for enormous depths."

At Gopeng and in the Kledang Hills, in Bujang, Malacca, and many other places in Perak, the pegmatites, where they have been softened by the kaolinisation of the felspar, have been worked for tin. In Pahang in various places, and in Negri Sembilan there are also instances of this class of workings. In the latter State large quantities of tin have been won by hydraulicing the soft pegmatite. The development of this source of supply must be slow, owing to the remote situation of the localities in which the deposits occur and the generally low average value of the mass. The occurrence also of hard portions, which will not yield to the influence of water, has hitherto retarded the systematic treatment of any of the known bodies of this class of rock, while the more easily won alluvial deposits still continue to provide remunerative employment for the mining labourer.

For the immediate future the tin supply from the Federated Malay States must continue to depend upon the alluvial resources; but as these become less abundant, and as the mining of them gradually passes from the hands of individuals into those of companies, then more attention will be given to the development of the lode resources, and important and valuable discoveries are certain to follow.

Australasia.

Next in importance to the Federated Malay States as a source of our tin supply is Australia, with which I include Tasmania. The output for the twenty years ending 1909 was 161,560 tons, the average yearly production from each colony being :—

	Tons.		Tons.
Tasmania . . .	3178	. Highest in 1908 .	4520
Queensland . .	2733	. „ „ 1907 .	5140
New South Wales	1685	. „ „ 1890 .	3668
West Australia .	482	. „ „ 1907 .	1424

Tasmania's production in 1909 was 4,511 tons, the chief mines being Mount Bischoff, Mount Bischoff Extended, Pioneer and Gladstone District Alluvial Mines, the Briseis group, Moorina District, Weldborough Mines, Blue Tier, St. Helens and Avoca.

Of these Mount Bischoff has been working since 1872.

This mine is situated in the north-west, some 45 miles from the coast, on the top of a mountain 3,500 feet above sea-level and 1,200 feet above the surrounding plain.

W. von Fircks, in a paper describing the deposit, writes :—"The tin deposits appear in an area of quartzites and clay slates with dykes of quartz porphyry. Granite is present, but at some distance from the mine. These deposits are in part fissure veins carrying cassiterite . . . Another part of this deposit is formed chiefly by the replacement of porphyry dykes."

The ore is generally of low grade, the average for the whole mine being about 1¼ per cent. cassiterite. It is mined chiefly by open quarries, the ore being broken and dressed by means of stamp battery, tables, buddles, etc.

On the north side of the hill some good alluvial was found and worked, and from the whole mine, since work was commenced up to the end of 1909, over 68,000 tons of ore have been won, and at present the average monthly output is about 85 tons of ore.

Mount Bischoff Extended is also a lode deposit producing about 10 tons of tin monthly.

Pioneer Group of Alluvial Mines in the north-east are working alluvial drifts in the Ringarooma Valley by means of suction dredges down to depths of 120 feet, the output amounting to about 90 to 100 tons of ore monthly.

The Briseis Mine and Brothers' Home are hydraulic propositions in the Derby district, working a gravel deposit covered by barren overburthen consisting of basaltic soil in which occur hard basaltic boulders. Water was introduced under pressure from a distance of 30 miles, so that the whole can be treated by hydraulicking, excepting the rocks and boulders, which have to be trucked. During 1909 little short of 1,000 tons of tin ore was saved.

Of the other alluvial mines there are none deserving of special mention.

The Anchor Tin Mine in the north-east works a mass of comparatively soft tin-bearing granite, the whole of the stone broken being taken to the mill and crushed; and mining about 1 per cent. tin ore can be made to pay, as the costs are kept very low.

A new tin-field has recently been discovered on the Stanley River, south of Mount Bischoff. Here prospecting has proved alluvial deposits averaging for a depth of 39 feet 4 lbs. of tin ore per yard, and there are lodes said to be worth 7 per cent. of cassiterite.

Latest reports point to increased activity in the tin-mining industry in Tasmania, and the introduction of hydro-electric power should stimulate the production by reducing working costs.

When dealing with tin the Report of the Government Department of Mines, Queensland, for the year 1909, states :—

"The steady and satisfactory price of tin

throughout the greater part of the year has been reflected in the activity in this branch of the industry, more especially in Herberton and Chillagoe Fields, where new lodes have been discovered, old workings have been reopened, and richer and more extensive ore bodies have been disclosed in some of the established and productive mines."

The Vulcan Mine in this district has, by fresh discoveries, developed promising ground for the future in the lower levels on the lodes, but at Stannary Hills the promise, based on borings by diamond drills, of further valuable ore bodies, has not been realised. Koorboora, in the Chillagoe division, has improved its position by the discovery of a valuable lode worth 20 per cent. of tin oxide, but generally in this district the ore deposits seem to be of an uncertain nature, and the alluvial workings have ceased to be productive.

In the Kangaroo Hills Field the easily won alluvial tin has almost been exhausted, and lode workings have not been sufficiently successful to induce any fresh developments.

In the Cooktown district the alluvial mines with an increased water-supply are now doing better, but of lode tin in this district but little has been won, and, notwithstanding the increased value of tin, there does not appear to be any prospect of any increase in the output of this colony.

In New South Wales there was a small increase to record in the production during 1909, due to increased activity in dredging operations, which produced 69·5 per cent. of the total yield of tin, chiefly from Tingha and Vegetable Creek, but with good assistance from Wilson's Downfall and Glen Innes Division. During the year it is recorded that mining for lode tin came in for little attention.

In Western Australia the output has also considerably decreased, being 225 tons less than during 1908. Practically the whole was produced from two fields, the Pilbarra and Greenbushes, and, in the Report of the State Mining Engineer, no hope is held out of there being any prospect of an improvement, though the lodes at Greenbushes may prove valuable if sufficient capital for their development can be obtained.

South Africa.

The Bushveldt Tin Mines in the Transvaal were at one time expected to prove large producers. They were favourably reported upon by an expert, and a strong company was formed, but the result of their operations has not been satisfactory, and the mines are said to be still in a state of development.

The Kuils River alluvial deposits near Cape Town have not produced any significant quantity of tin, but the Zweiplaats Mine, working pipes in granite, is now doing well, the ore treated averaging 20 per cent. tin oxide.

It is, however, from Swaziland that most of the South African tin comes. Here, in 1889, Mr. Ryan discovered alluvial tin in payable quantities, and alluvial deposits of considerable value and importance are known to exist in the valleys of the Embabane and Usutu rivers.

Swaziland Tin, Limited, has been operating during three years with very gratifying results for its shareholders.

At first, operations were confined to ground sluicing, manual labour serving to shift the ground. Recently, however, a hydraulic installation has been completed which in last year, during the months of July, August and September, produced 91·5 tons of tin. This result, obtained during the driest months of the year, can, the manager confidently states, be largely augmented when more water is available. The company has in hand the introduction of further water-supply, and prospects for the future are considered very bright.

Sketchy prospecting in many of the beds of the tributaries of the Embabane proves that there is tin in all the valleys, and as prospecting in a more systematic manner and on a large scale is about to be undertaken, important developments may be looked for.

Nigeria.

Much attention has of late been attracted to Northern Nigeria and the tin deposits there discovered.

That tin was found in Nigeria has been known for many years, owing to "faggots" of pure tin having from time to time found their way down to the coast; but it was not until 1902 that any serious endeavour was made to trace the source of the supply.

In that year the Niger Company despatched an expedition, under Mr. Laws, to examine the country, and tin was discovered in the province of Bauchi.

Within the past few years many companies have been formed to develop the tin-fields. All of these companies are represented on the ground by their managers and assistants, but even now there is very little reliable information available as to the value or extent of the alluvial deposits.

Reports published with prospectuses bristle

with glowing accounts of wonderful rich finds, but on analysis there seems to have been very little prospecting on systematic lines.

Attention has been mostly, if not entirely, given to shallow deposits in the river beds near the sources of the streams, and though undoubtedly rich pay dirt has been found in places, as is evidenced by the tin ore exported by the Naraguta and a few other mines, the nature of these deposits points to the conclusion that they are concentrates behind natural bars—that they will eventually prove to be patchy and of short life.

Mr. A. F. Calvert, in his "Tin Fields of Nigeria," gives much interesting historical information and a very full account of the various Nigerian companies, with details of reports by their experts; but, apart from the historical matter it contains, the book is of little value as a work of reference, most of the information being of an *ex parte* nature.

The *Mining Journal* of the 19th November last contains an article, "from a correspondent," on Northern Nigeria. The article commences by stating that, after several months in the country, the writer still has difficulty in obtaining any reliable data. "With regard to the 'power' companies here, I think that this phase of mining, if on a large scale, may be dismissed altogether. . . . The situation, in a few words, is too much water in the rainy season, and too little or none in the dry season. In some localities the river water dries up altogether.

"But I put these facts forward as a counterbalance to the undoubted richness of much of the ground taken up.

"*Values.*—Information is not available as yet, everyone being absorbed in taking up areas . . . I have seen ground in Ninghi going at least 5 lbs. of very coarse cassiterite per cubic yard; the average all over will remain at this figure, or drop to 4 lbs. throughout . . . This instance is, however, exceptional, I should say, taking into consideration the coarse nature of the ore.

"Very few properties are being taken up on the square area, owing to tin not existing in many cases outside of the actual river bed or far into the banks. . . . These areas of six miles by half a mile will, when producing, probably average all round from 4 to 5 tons ore per month, but it will take some getting."

Of labour there is a good supply available at low rates of wages, but until the railway is completed to the coast, the cost of transport to and from the mines (estimated at £25 to £30 per ton of ore) must hamper the development of the fields, which, for this reason, will be slow; and, therefore, a few years must pass before Northern Nigeria will be able to demonstrate the position it can take among the tin resources of the Empire.

Cornwall.

Cornwall at one time produced 14,000 tons of tin annually, but the average for the ten years ending 1910 has fallen to 4,800 tons.

With the exception of the famous Dolcoath Mine, very few of the many mines in Cornwall are worked at a profit, and, passing through the county, one sees abandoned mine workings on all sides. Many mines still continue to operate year after year, but without any benefit to the shareholders, and it would appear that the mines are run more for the sake of the employment they provide than for anything else. Their condition does not seem to improve with an advancing price of tin—a fact probably due to advantage being taken of the higher price to work poorer ground and to develop more reserves as a stand-by when the inevitable fall occurs.

A few years ago much was said and written of the improvements that could be effected in Cornish mines if the prejudice for antiquated Cornish methods of mining and ore-dressing could be eliminated. Several companies with ample capital were floated to demonstrate the truth of this theory. Much work was done, much money was expended, but the superiority of the newer methods still remains to be proved—at least, in so far as shareholders are concerned.

The main factor which militates against the success of Cornish mines is the depth at which mining is carried on, and the quantity of water that has to be pumped. As an instance of this, the Basset Mines have to pump from a depth of 1,800 feet 90 tons of water for every ton of ore raised. Pumping charges alone on this mine amount to 5*s.* 4*d.* per ton of ore, which on 42,500 tons of ore (the amount mined in 1909) means a sum of £11,328.

There does not appear to be any prospect of improvement in the mining industry in Cornwall. Probably the output will continue to be maintained at or about the present level of 5,500 tons, but any material increase is unlikely.

Attention has recently been given to the alluvial deposits on the Goss Moor, where a centrifugal dredging plant has been erected. So far the ore won has not covered working costs, but better results may be obtained when

those responsible for the running of the plant become acquainted with its idiosyncrasies.

Farther east a bucket dredge is in course of erection, and its operations will be watched with interest, but under no conditions are the alluvial deposits of Cornwall likely to make much difference in the world's tin supply.

TIN SUPPLY IN TONS OF 2,240 LBS.

YEAR.	Shipments from				Banca Sales in Holland.	Billiton Sales in Java.	Production in Cornwall.	TOTAL.
	Straits.	Australia.	Bolivia.	S. Africa.				
1909	58,500	5,350	18,000	3,000	11,600	2,200	5,600	104,250
1908	60,500	5,850	17,000	1,700	11,500	2,200	5,400	104,150
1907	52,500	6,350	15,300		10,890	2,150	4,900	92,290 (*a*)
1906	57,200	5,900	16,380		8,980	1,900	4,900	96,760 (*b*)
1905	57,000	4,900	11,900		9,625	2,625	4,500	90,550

(*a*) Includes 200 tons from China. (*b*) Includes 1,500 tons from China.

From the above table it will be seen that in 1909, out of the total world's supply of 104,250 tons of tin, 72,450 tons came from within the Empire, though some of the tin shipped as "Straits" was mined in the independent States of the Malay Peninsula and in Billiton and Singkep.

For years to come there should be no difficulty in maintaining this rate of production. In fact, there appears to be more probability of an increase than of any falling of.

The high value at present of tin is certain to stimulate production throughout the Empire, with the exception of the Federated Malay States, where, as statistics prove, the production decreases as the value of the metal increases. Any falling off here, however, should be made good as the development of Northern Nigeria and Swaziland goes on, so that there is no reason to fear that the world's requirements for tin will not be amply provided for in the future, as has been the case in the past.

DISCUSSION.

MR. HERBERT W. ELY (Secretary, Tasmanian Government Office), in opening the discussion, after apologising for the absence of Dr. McCall, the Agent-General for Tasmania, thought the author was to be congratulated on a paper which was not merely interesting to professional mining men, but also to the mere layman. Tasmania was the principal tin-producing State of Australasia, and it prided itself on the fact that it now possessed the largest tin mine in the world, which was also one of the best-paying mines. It was only some thirty-five years ago that the statement was made that the Mount Bischoff Mine was petering out, and would have to close down; but it had gone on ever since, and had been a regular dividend-payer for over thirty years. He confessed to a feeling of disappointment that the author had not mentioned, in connection with the mining districts of Tasmania, the large tin-field of north-east Dundas. It had not been very much worked up to the present, but the district was a very large one, and was highly tin-bearing, both alluvial and lode. Farther to the west there was the Stanley River field, which had proved to be extremely rich in tin, and there was every indication to show that when those districts were opened out, Tasmania would, within the next few years, double or perhaps treble its output of tin. The author had stated that there were no bucket dredgers in the Malay States. This was true, but, as a matter of fact, there was a Tasmanian company operating at Tonkah harbour, about 200 miles north of Penang, and successfully dredging the harbour for tin by means of bucket dredgers. It would be of interest if the author could state whether the success of tin-mining in the Straits Settlements was due to the high percentage of tin obtained, or the cheapness of the cost of production, including labour. It was quite conceivable that in places where labour cost only a few shillings a week, tin deposits could be worked profitably, whereas the reverse would be the case if the Australian rate of wages of 8*s*., 10*s*. or 12*s*. per day had to be paid.

MR. T. L. LEWIS stated that he had travelled all over the world searching for tin and gold. In Bolivia he had ridden for four days over country in which he had picked up pieces of alluvial ore, as large as his head, almost every five minutes. He brought some of those pieces home to England, and on their being assayed by an eminent tin expert they gave 27 per cent. of tin. He believed that in the future no country would be equal to Bolivia in the production of tin. He had made a careful study of the tin-bearing districts of Cornwall, and believed that that county possessed a very large area of some of the finest alluvial tin country in the world. He further believed it would be found

that Cornwall in the future would produce tin in very large quantities, which, if not exactly up to the scale of its old production, would very nearly equal it. There were tin values in Cornwall which were very much higher than the general average values he found in Australia, while the quality of the tin in Cornwall was about the best in the world. He firmly believed that in the future there would be a big alluvial tin industry in the county. Miners did not yet know all that was to be learned with regard to the saving of tin, no system having yet been adopted by which the finer tin might be saved, and the general output of the metal thus increased. The author had stated that tin alluvials contained platinum and gold, but he had not mentioned wolfram. He had seen alluvial deposits in Cornwall containing wolfram, which would pay handsomely if worked on modern lines.

Mr. J. H. COLLINS said the author had made the statement that the mines of Cornwall were mainly worked for the benefit of those who worked them. As a mining man, he would like to know whether the same remark did not apply to the mines all over the world. If the author tried to maintain that in that respect Cornishmen were different from other people, he thought he would fail absolutely. There was a very simple reason for the decline in the production of tin in Cornwall in the last few years. Not many years ago tin was being raised in twenty different districts in Cornwall, while it was now being raised in any quantity in only three districts. There were fashions in mining as in everything else, and some of the mines had gone out of fashion. They would come into fashion again in the future, but the great district which had yielded the largest amount of tin in Cornwall for many years past had maintained its output. Although Mount Bischoff had a great reputation and record, he thought no other tin mine in the world had a record like Dolcoath, which had been working continuously for a great deal more than a century, giving fair profits for a very great part of the time. By-and-by, when Cornwall came into fashion again, and the derelict districts were reopened, the production of tin in Cornwall would increase to something like what it was previously, and the dismal predictions which had been put forward in regard to the industry in that county would be found to have no ground for justification whatever.

Mr. WILLIAM S. LOCKHART mentioned that for the sake of completeness he thought the paper should state that tin existed in the western part of Devon, as well as in Cornwall. Although Devon was not at present a large producer, he believed that alluvial tin from Devon occasionally came into the market. In wandering round Dartmoor, visitors would see that recent tin-streaming work had been done, and ample evidence, not only of the "old man," but also of the "ancient old man," as the tin-streamer of antiquity was locally termed. He desired to emphasise the previous speaker's remarks with regard to the tin alluvials of Cornwall. Alluvial tin was worth more than mined tin, and now that wolfram was commercially utilised, and could also be efficiently separated from the tin, there was far more inducement to work the alluvial tracts of the county. With better methods of mining, and a more thorough grasp of local conditions, he believed alluvial tin-mining in Cornwall would become a profitable industry. He desired to ask the author whether much wolfram was found in the tin deposits of the Malay Peninsula. He had been much interested in the author's remarks as to the white limestone, as he had met with an apparently similar formation of massive white calcspar in the ruby mines of Burma. Occasionally there were vast caves in this rock containing rich alluvial deposits, from which the finest rubies were obtained. It would interest him to know if such caves existed in the formation referred to by the author, and also whether tin occurred actually in the rock itself.

Mr. C. G. MOOR thought the principal reason Cornish mines had not paid was that the miners commenced mining from the top, instead of from the bottom. That process had had the effect of letting the surface-water down into the mines, and it would eventually drown them out. More modern methods of sinking a deep shaft avoided that drawback, and it was a point worth considering in opening up a new mine. The author had referred to the Anchor Tin Mine, in Tasmania, and had stated that mining about one per cent. tin ore could be made to pay. As a matter of fact, the actual recovery in that mine was no greater than 3½lbs. of black tin per ton of rock crushed, and that ore had to be blasted out of the face of a mountain. It was the most remarkable tin mine in the world for the low cost of working, and, so far as one could tell, it might be inexhaustible. It was simply a huge mountain of granite, 700 tons of which were being crushed per day. He hoped something would be said, in the course of the discussion, about the tin-fields in the Tanganyika district, some statements he had heard with regard to the discovery of tin there being to the effect that those tin mines would eclipse every other mine in the world. He wished the miners every success in working the alluvial tin ores of Cornwall, but the great difficulty experienced there was that only a few landowners would give permission to sluice off the surface of the property. In Tasmania no one said anything if the miner washed away the whole side of the hill; but it was seldom allowed in this country. It also had to be borne in mind that most of the alluvial tin that had been profitably won in Cornwall was obtained when wages were something under one shilling a day, and not four shillings, as they were at the present time. He thought there must be gentlemen present at the meeting who had first-hand knowledge of every tin-field in the world, and he suggested that most valuable information would be obtained if those gentlemen were to add to the information about the particular district with

which the author had dealt, contributions in regard to all the other tin-fields of the world.

Mr. JOHN VIVIAN asked what was the amount of royalty paid by the Malaya Tin Mining companies to the State. In Cornwall it was usual for the miner to have a twenty-one years' lease, a royalty being paid of anything from one-twentieth to one-thirtieth of the whole of the produce. That was one of the reasons for the decreasing output in the Cornwall mines. In the mine with which Mr. Collins was connected, a profit of over £17,000 had been made, and out of that amount over £3,000 had been paid in royalties. He agreed with the previous speaker that the day was coming when not only the alluvial deposits of Cornwall, but also many of the mines which had ceased to be worked during the time of the very low price of tin would be worked again. Given sufficient capital, men who thoroughly understood the work, and fair terms for the working of the mines, Cornwall would again be one of the largest tin producers of the world.

Mr. SYDNEY FAWNS, in referring to the quotations from various books given in the paper, said that Mr. Lock in his book used the word "lode" mostly in a commercial sense, whereas Mr. Scrivenor and he used it from the scientific standpoint. The remarks made with regard to the Sungei Ayam did not agree with Mr. Lock's opinion. There was no doubt there about the lode entering the country rock, but it was not payable, and this opinion was endorsed by Mr. Scrivenor. Personally, he looked upon Mr. Scrivenor as the best geologist Malaya had ever possessed. Another point in which he differed from the author was that all the tin came from the lodes, but why should not the stockwerks and dykes be responsible for it to a very great extent? If the author had made a short statement in regard to the extraordinary deposits the French were working in the limestone, it would have been most interesting. The only similar instance of which he was aware was the tin obtained from the limestone in Greenland; but in that case the undertaking did not pay, owing to the rigorous climate. He further wished to say that Mr. Laws was not the discoverer of tin in Bauchi. The first man who went to the tin-fields of Northern Nigeria was Richard Provis, and the next man—who was the real discoverer—was Mr. G. R. Nicholas. Laws replaced Nicholas after the latter came back; but, on the other hand, he thought Mr. Laws deserved great credit for staying for three years by himself in a country inhabited by cannibals. That, in his opinion, was one of the finest pieces of work any engineer had ever done. The paper was a most valuable one, but he wished to throw out the suggestion that the author would do an excellent piece of work if he would write a paper for the Institute of Mining and Metallurgy, giving details of the costs of working, costs of pumping, and a few drawings. Such information from a practical man like the author would be most valuable, if he could provide it without giving away official secrets.

Sir WILLIAM TAYLOR, K.C.M.G. (late Resident-General, Federated Malay States), spoke of the increasing opening that existed for the employment of European capital, enterprise, and supervision in the more effective and scientific exploration of the tin-fields of the Malay Peninsula. Owing to the interest that people took in rubber at the present time, something was getting to be known about that part of the Empire, so far as the cultivation of rubber was concerned, but comparatively few people appeared to know anything about the great mineral wealth of the country. Few people knew about its tin-fields, and still fewer about how much tin had done for its development and expansion. It was largely due to the revenue derived from the royalties collected on the export of tin that the administrators of the country had been able to do so much in the way of development—in the making of roads thousands of miles in length, the building of railways, the creation of harbours and towns, and the construction of public works generally. The revenue had increased in the thirty-five years that the Malay States had been under British protection and under the control of British officers, from less than £80,000 in 1875 to close on three millions in 1909. There had also been a marvellous expansion of trade, unparalleled in a country of its size and population. In 1909 the value of the exports amounted to nearly nine millions sterling, and the imports to nearly five and a half millions sterling, more than two-thirds of the former being accounted for by tin. The natives of the country had not taken an active part in the development; the Chinese, the natives of Southern India, and the British had been responsible for it. Nevertheless, the people of the country were prosperous, contented, increasing in numbers, and were well looked after by a stable and paternal Government, which provided them with education and other so-called blessings of civilisation, of which they were not slow to take advantage.

Mr. F. DOUGLAS OSBORNE, in reply, said that Mr. Ely had asked if he considered there was any special reason why so much tin was won in the Federated Malay States, and if that reason was not more than probably due to the fact of lower rates of wages being payable there than in the Australian colonies and most other places where tin was won. He did not think it was, for the reason that where Mr. Ely was able to employ one intelligent European it was generally necessary to employ four or five Asiatics and negroes, in addition to providing European supervision to see that they did not sleep too much. He was afraid Mr. Collins did not quite appreciate what he said with regard to the mines in Cornwall. He said it appeared that the mines were run more for the sake of the employment they provided than for anything else. That certainly was not the case all the world over. People generally put money into a venture for the sake of what they could get out of it, and not for the philanthropic reason of providing labour for

a certain number of men. With regard to the remarks of Mr. Lockhart, most people knew that a certain amount of tin came from Devonshire, but the quantity was so very small that it was hardly worth mentioning. Wolfram was certainly found in the Malayan tin deposits. He should have mentioned that himself if he had been describing tin; but the statement made in the paper that tin, platinum and gold were found in the alluvial deposits was a quotation from a book by Professor Lewis, published by the *Mining Journal*. "Amang" might be taken as being a generic term for anything that was not easily separated from tin. It occurred in various forms, but principally in the form of titaniferous iron. He had also been asked whether tin occurred in the limestone caves and deposits. He made mention of that fact in his paper, and endeavoured to account for its presence there. Tin was also found in crystals in the limestone. Mr. Sydney Fawns had drawn attention to his neglect to deal with the very interesting deposit which was worked in Kinta. His reason for doing so was that the deposit had almost entirely ceased to exist; it had been completely mined out, and to deal with the subject at all called for a paper in itself. Mr. Vivian asked what were the royalties paid in the Federated Malay States, and in what way they compared with the very heavy dues paid in Cornwall. In the Federated Malay States, the mining land was held by the miners under a lease from the Government for twenty-one years. The royalty paid to the Government was not one based on profits, but on the gross value of all the tin won, and it amounted at present, roughly speaking, to 12 per cent. of the total value. It was on a sliding scale. He was glad to accept Mr. Sydney Fawns's corrections, because his own knowledge of Nigeria was nil. He worked hard to gather some information with regard to Nigeria for the purpose of the paper, and there were only two sources from which he could get it—the *Mining Journal* and Mr. Calvert's book. Unfortunately he took one extract from that book, and it happened to be wrong.

On the motion of the CHAIRMAN, seconded by Mr. BYRON BRENAN, C.M.G., a vote of thanks was accorded to Mr. Osborne for his valuable paper, and the meeting terminated.

TENTH ORDINARY MEETING.

Wednesday, February 15th, 1911; JOHN MURRAY, J.P., D.L., F.S.A., in the chair.

The following candidates were proposed for election as members of the Society:—

Bell, Thomas, Messrs. John Brown & Co., Ltd., Clydebank, Scotland.
Byrne, James, 24, Broad-st., New York City, U.S.A.
Cookson, Clive, Oakwood, Wylam, Northumberland.
Dubilier, William, 431, Lumber Exchange Building, Seattle, Washington, U.S.A.
Lee, Harold, 56, Oxford-street; and Fairfield, Broughton Park, Manchester.
Lello, Thomas Stanley, High-road, Chadwell Heath, Essex.
Mackay, Robert John, Secretary's Office, General Post Office, E.C.
Mansell, Walter H., 405, Oxford-street, W.
Pitt, T. E. Sandford, Calne, Wilts.
Srivastava, Jwala Prasad, B.Sc., Municipal School of Technology, Manchester.
Sunderland, John Samuel, 37, Aberdeen-road, Highbury Park, N.
Todd, John, Hamilton House, 155, Bishopsgate, E.C.

The following candidates were balloted for and duly elected members of the Society:—

Bell, A. Mitchell, 56, Stanley-road, Halifax, Yorks.
Hill, W. Hereward, Canton, China; and Fairmount, Sidcup, Kent.
Hope, William Henri, The Studio, South Croydon.
Miles, T. R., 9, Brighton-terrace, Brixton, S.W.
Oosman Sahib, Khan Bahadur S.M.V., B.A., B.L., Presidency Magistrate, Madras, India.
Pillai, Perumana Narayana, Kayangulam, Travancore, India.
Sykes, John Guttridge, 88, Marlcliffe-road, Hillsborough, Sheffield.
Young, Rev. William Edward, Brook Lawn, Queen's-road, Teddington.

The CHAIRMAN, in introducing the reader of the paper, said the statement was often made that people who lived at the present time would frequently be placed in a difficulty if they had to describe to their forefathers the familiar articles in everyday use. For instance, how many of the audience would be able to describe the telephone or the locomotive to Dr. Johnson? It was a discredit to the nation that such should be the case; and as bookbinding was one of the most familiar subjects, he felt sure a great deal of information and profit would be derived from the paper.

The paper read was—

MODERN MACHINE BOOKBINDING.

By GEORGE A. STEPHEN,

Chief Assistant Librarian, St. Pancras Libraries.

The present epoch is pre-eminently an age of machinery, and consequently an age for cheapness. Necessity being the mother of invention, the insatiable desire of the masses for a cheapening of manufactured articles has resulted in the invention of ingenious mechanical contrivances for minimising hand-labour in all departments of manufacture, including the making of books.

Machine bookbinding was solely a product of the nineteenth century. At the time of the Great Exhibition of the works of Industry of all Nations in 1851 it was in its infancy, yet the jurors of the bookbinding section were jubilant at the great strides which they considered had then been made. The following extract from the jury's report concisely states the extent of machine bookbinding at that time:—

"Mr. Burn, of Hatton Garden, first introduced rolling machines to supersede hammering. The

iron printing presses of Hopkinson and others were altered to form arming-presses, by which block gilding, blind tooling, and embossing can be effected with accuracy and rapidity. Leather covers, embossed in elaborate and beautiful patterns by means of powerful fly-presses, were introduced by M. Thouvenin, of Paris, about twenty-five years ago; and almost simultaneously in this country by Messrs. Remnant & Co., and by Mr. De la Rue, who were quickly followed by others. Embossed calico was also introduced about the same period by Mr. De la Rue. Hydraulic presses, instead of the old wooden screw presses; Wilson's cutting machines, which superseded the old plough; the cutting-tables with shears, invented by Mr. Warren de la Rue, and now applied to squaring and cutting millboards for book-covers—all these means and contrivances, indispensable to large establishments, prove that machinery is one of the elements necessary to enable a binder on a large scale to carry on that business successfully."

Since the Great Exhibition the incessant demand of the public for cheap books, and the acute competition of publishers and authors, have combined to stimulate mechanicians to produce machines for the efficient execution of almost every process in printing and book-binding, and the natural result to-day is a plethora of books, good, bad and indifferent.

Before proceeding to describe the various processes in edition binding, it may be of interest to refer briefly to some of the machines used for pamphlet and magazine work. For pamphlet work wire is generally preferred by binders on account of the economic advantages to be derived from its use. There are on the market a great variety of wire-stitching and binding machines for stitching single sections through the centre of the fold, or for binding together several sections by stabbing them through the left-hand side. The greatest thickness a wire-stitching machine can pierce is $1\frac{5}{8}$ inches; this extraordinary work is accomplished by a machine made by Mr. Aug. Brehmer. Thread-stitching machines are rapidly displacing wire-stitching machines for certain classes of pamphlet work. The Elliott, Brehmer and Martini thread-stitching machines effectively stitch pamphlets up to about a quarter-inch in thickness, through

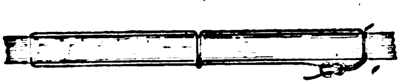

FIG. 1.

the fold or through the side; they are fitted with mechanical devices which make the holes, draw the thread through them, tie a tight reef-knot, cut the thread, and pick up the end of the thread again for the next pamphlet. A machine-made stitch can easily be recognised, as the knot is always tied at one end of the stitch, as shown in Fig. 1, whereas in hand-stitching it is invariably tied in the centre of the stitch.

For periodicals, such as *The Graphic*, Messrs. Harrild's "Graphic" folding machine is used; this machine will fold, inset, cover and stitch with two wire staples, two sixteen-page sheets, one four-page inset and a four-page wrapper, delivering the whole, folded and stitched, ready for trimming. It will also fold and stitch one whole sheet of sixteen pages, half sheet of eight pages, quarter sheet of four pages, with the cover, at one operation; or two half sheets, one quarter sheet, with a four-page or eight-page wrapper. The machine can be altered from whole sheet to half sheet, or from two whole sheets to two half sheets, or *vice versa*, while it is running.

The present method of securing the leaves of the *Strand Magazine* has caused considerable comment, favourable and otherwise. The binding is done entirely by an ingenious machine, known as the Sheridan "Perfect Binder," working at a rate averaging about 1,400 copies per hour; this machine, which has revolutionised the methods of binding magazines, secures the leaves by processes similar to those of the india-rubber binding, patented many years ago by Mr. Hancock. After a complete magazine, minus the cover, has been placed between one of the thirty pairs of jaws, it travels round the machine, and during its progress the following operations are effected: the edges of the folds of the sections are cut off; the edges are roughened to prepare them for receiving the adhesive; the adhesive, a strip of mull, and the cover are then applied in rapid succession; and the magazine is finally delivered upon a receiving table. The magazines are allowed to stand for several hours until the adhesive has set, and then they are trimmed by a cutting machine in the ordinary way.

In edition binding several of the processes continue to be done by hand in most English binderies, but as machines have been constructed for almost all processes, handwork will not be described in the following account. The first operation in edition binding is folding, for which many machines have been constructed; some of them are fed by hand, while others have a self-feeding attachment. The principle on which the folding of the sheets is effected by most of the machines is very similar; the sheet is placed beneath a folding-blade, correct register being obtained by feeding according to guides, or to "points" or small slits; the blade descends

and presses the sheet between two rollers which make one fold; the sheet is then automatically carried to another pair of rollers and folded again, and this process is repeated until the desired number of folds has been made, when the folded section is delivered into a receptacle at the bottom of the machine. Some of the machines insert one section within another before delivering them.

After the sheets have been folded into sections they are tied up in bundles to prevent the different sections being mixed; this work is generally accomplished with the aid of a bundling press, by which the sections can be tied up in bundles of equal size under great pressure, and then stored in the least possible space.

If the book is to contain plates or maps, they are tipped (*i.e.*, pasted) to their respective sections, and the end-papers are attached to the first and last sections of the book. There are machines even for this work, and they accomplish it with a neatness and speed that are truly astonishing. Brehmer's end-sheet pasting machine for attaching end-papers or plates to sections is simple and effective; the operator feeds a section and the end-paper or plate to two flaps, and the machine brings them together, applies the adhesive, presses them, and delivers the combined section. An American machine of more complex construction is known as the Lewis end-papering machine; this is designed to cut, fold, and tip on end-papers to the first and last sections of a book concurrently.

The next process is "gathering." For this process there are several different machines, the action of some of which, such as Mercer's, Juengst and Son's, Plimpton's, and Gullberg and Smith's, is similar; piles of the sections which are to constitute complete books are placed in a series of boxes, from which they are automatically withdrawn and delivered on to an endless band which travels in front of the boxes; by the time the band has travelled across the machine a complete set of sections has been obtained, and it is only necessary for the set to be removed by the girl. Mr. Oscar Friedheim's machine, invented in 1908 by Mr. James Abel, occupies considerably less space than those with travelling bands; it consists of a series of ten trays attached to two endless chains on sprocket wheels carried by two shafts mounted on a frame. The sections are placed in the trays, each of which is arranged to take piles of six sections side by side, and a girl is placed on either side of the machine to gather the sections as the trays rise and fall. The "Express" collator of Messrs. Walker Bros. occupies about the same amount of floor space as Friedheim's machine, viz., six feet square. It consists of a rotating cabinet having three tiers, each of which is divided into sixteen compartments to take sections of the size of an imperial folio, but more compartments may easily be provided for sections of smaller size, by rearranging the partitions. During each revolution the machine stops eight, twelve or sixteen times to enable the gatherers (four or six of whom can sit around the machine) to extract a section from the compartment in each of the three tiers directly in front of them.

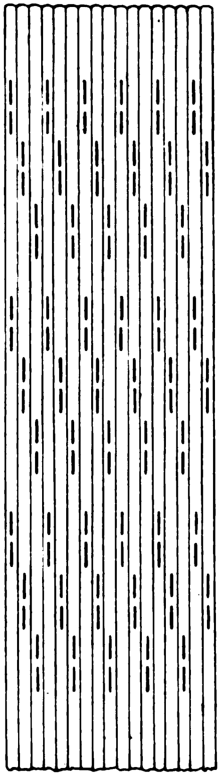

FIG. 2.

The book must next be collated to see that all the sections are in their proper sequence, and that none are in duplicate or missing. The book after being collated is ready for the important operation of sewing, the process upon which the durability of a book so largely depends. Wire and thread are both used for the sewing of books, but in this country the latter material is now used for practically all letterpress books. In Germany, however, books are commonly sewn with wire, and there are many wire-sewn books, including Baedeker's important guides, to which very little objection can be made from the

points of view of serviceability and durability. In wire-sewn books the sections are attached to a common foundation of mull, canvas, or tapes, by staples which are driven through the section (from the inside) and the back fabric, and then clinched at the back. Baedeker's guides and Brockhaus' Encyclopædia are sewn on Brehmer's wire book-sewing machine, which is a typical one. This machine inserts the staples in adjoining sections in different positions, as shown in Fig. 2, in order to reduce the swell in the back of the book; thus two or three times as many rows of staples appear on the back of the book as there are staples in each section; for the sake

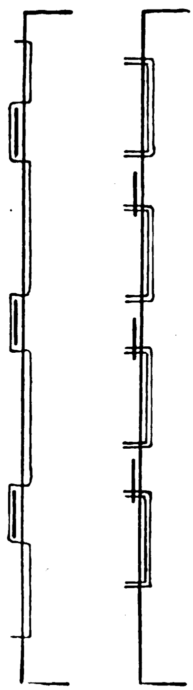

Fig. 3.

of clearness the back fabric is not shown in the illustration. This method of sewing with wire is quite strong, but, as wire does not yield as readily as thread, wire-sewn books are usually less pliable than books sewn with thread, and therefore they are disapproved. With much use the leaves of wire-sewn books are more liable to become loose than those sewn with thread, because the two or three small staples used only secure the leaves to the back fabric to the extent of about 1½ inches, whereas leaves sewn with thread are generally secured about three-quarters of their entire length. The greatest objection to wire-sewn books, however, lies in the fact that sooner or later the wire will rust and rot the paper and the back fabric to which the book is secured, so that the book will fall to pieces, and cannot be rebound without first repairing every fold. Doubtless, if only alumenoid wire were used, this latter objection would be removed, but its price is almost prohibitive.

In England and in America thread book-sewing machines are used almost exclusively for commercial bookbinding. There are now several efficient machines, each of which is adapted for several different kinds of work. By the use of one or other of these machines, books may be sewn on the principles known as "all along" and "two sheets on," the sewing may be plain, through mull, through or over tapes, or over cords, and the stitches may be of different lengths. The principle of machine book-sewing differs essentially from hand-sewing; with one exception the machines sew inside the sections with double thread, and when sewing "all along" as many threads are used as there are to be stitches in a section. In hand-sewing one

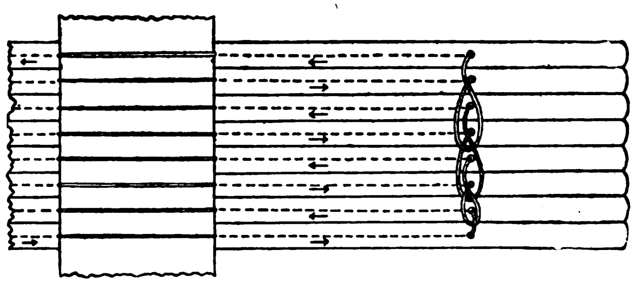
Fig. 4.

continuous thread is used which goes vertically through the whole length of each section, as shown at *A* in Fig. 3. In machine-sewing each length of thread in a given section is independent of the adjacent length, as shown at *B* in Fig. 3, the sections being united by a series of threads passing horizontally along the back of the book. Each thread in a machine-sewn book is inter-looped with itself, and embodied in each is a chain-stitch which the makers of the machines erroneously term a kettle-stitch. Machine-sewing is quite good, and is advantageous because the threads are held under even tension, and, being independent, a section cannot come out of a book until every stitch in the section has been severed; whereas in a hand-sewn book, if the thread be broken, not only will the section come out of the book, but the whole sewing will become loose. The machine chain-stitch, however, is not so strong as the hand-made kettle-stitch (Fig. 4), as may be seen by comparing the two Figs. 4 and 8, but as each machine-stitch

embodies a chain-stitch, the additional chain-stitches in a machine-sewn book compensate for any inferiority in this respect. In operation most of the book-sewing machines are similar; the section to be sewn is placed over an arm carrying punches which make holes in the sections to facilitate the ingress and egress of the needles, and the arm brings the section under several needles and hooks which sew the section.

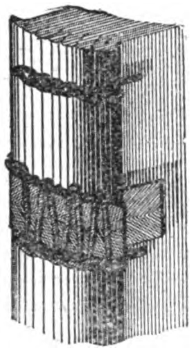

Fig. 5.

The Smyth book-sewing machines are of two kinds, the needles of which are curved, their curvature determining the length of the stitch; the one style has four feeding-arms designed for rapid work, and the other style has a single feeding-arm. Of the various styles of sewing done by the Smyth machines the following are selected for illustration:—Fig. 5 shows the style of

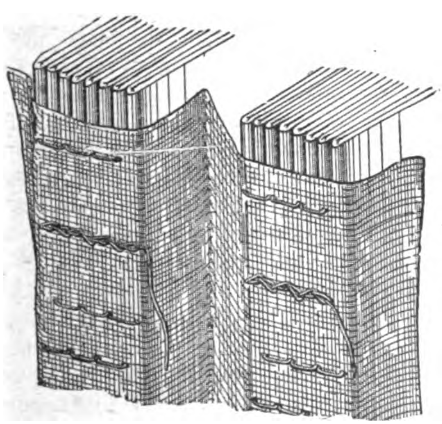

Fig. 6.

sewing done by the improved No. 3 machine (which has four arms) when sewing over tape; it will be observed that the two series of stitches are connected by an auxiliary thread (called a braiding thread), which holds down the tape. Fig. 6 is a sectional view of two books sewn through mull on the "two sheets on" principle as they come from the No. 7 Smyth machine, with the sewing-thread between them cut, but the mull uncut.

Brehmer's machines are of the single-arm type. One of them is different from all other book-sewing machines, as it sews with *single* thread "all along" inside the sections. This machine, unfortunately, cuts the head and tail of each section while sewing, as shown in Fig. 7, for the purpose of allowing a continuous thread to pass from one section to another in such a manner that the threads will not be cut by the guillotine when the edges of the book are trimmed. The

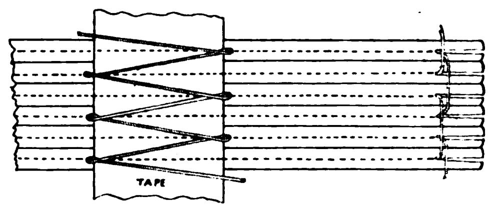

Fig. 7.

use of this machine should, therefore, be confined to "books which are no books"—to borrow a phrase from Charles Lamb—such as large directories and extra-thick books which it is desirable to sew with single thread in order to reduce to a minimum the swell in the back of the book caused by the thread. Three other book-sewing machines are made by Brehmer, and these are much to be preferred for ordinary edition binding. They sew with double thread, and use straight needles, which are adjustable so that the distance between the stitches and also the length of stitch may be varied. An illustration (Fig. 8) is given of the kind of sewing

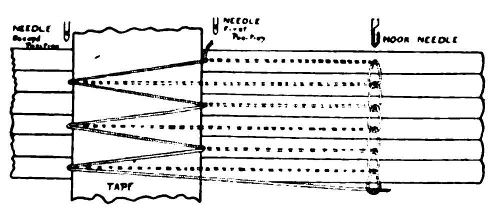

Fig. 8.

done by the No. 38 machine when sewing "all along" over tapes; the stitches in the adjoining sections are of different lengths, due to the automatic working of the needles, which carry the threads in a zig-zag direction over the tapes. The No. 33 machine is adapted for heavier work, and when sewing over tapes the threads are carried over the tapes in a double zig-zag direction to give additional strength. Fig. 9 illustrates the plain (or French) sewing done by this machine when adapted for sewing on the "two sheets on" principle.

The Martini book-sewing machines are also of the single-arm type, and are equipped with straight needles. The Martini machine, known as National No. 1, is arranged only for plain

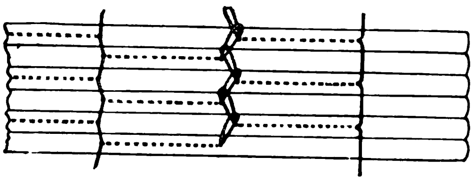

FIG. 9.

sewing or for sewing through mull or tape, or both together; this machine produces stitches of one length only, viz., $1\frac{1}{8}$ inches, and when sewing through tape the stitches are as illustrated at Fig. 10. The National No. 2 machine has several improvements; it will sew over tapes or cords, in addition to the styles of sewing done by the No. 1 machine; it will make stitches of several different lengths, and it has an automatic adjustable saddle which permits sections of different thicknesses to be sewn without any adjustment on the part of the operator. The stitches produced by this machine when sewing over tapes are similar to the zig-zag stitches shown at Fig. 8.

Messrs. Edler and Co. handle three book-sewing machines, which are known respectively as the "Universal," the "Victory," and the "Rapid" book-sewing machines. The Universal machine does various kinds of sewing, and makes stitches of three different lengths; when sewing over tapes the stitches are similar to those of

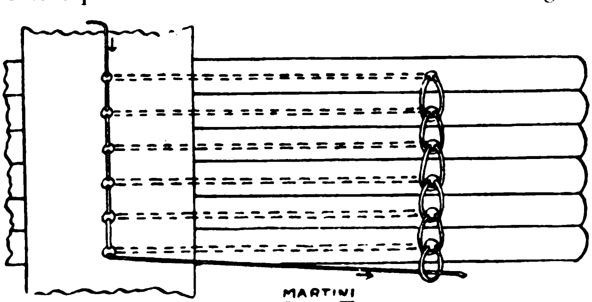

FIG. 10.

the Brehmer No. 38 machine, illustrated at Fig. 8. The Victory machine is similar in construction to the Universal machine, but is adapted for heavier work; instead of making an ordinary zig-zag stitch it makes a combined stitch of $2\frac{1}{2}$ inches and plain stitch of $\frac{15}{16}$ inch, or combined stitch of $3\frac{3}{4}$ inches and plain stitch of $1\frac{1}{2}$ inch, as illustrated at Fig. 11. The Rapid machine is for light work, and is so arranged that the sewing devices require no adjustment when changing from one job to another.

A machine specially adapted for sewing account books and books of a similar nature is

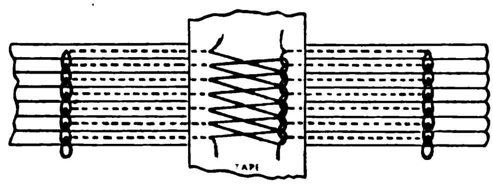

FIG. 11.

sold by Messrs. Marriott and Stewart; this machine works without stabbing needles, it sews over tape or canvas, or through tape, and produces a pearl stitch, as shown at Fig. 12.

After sewing, the book is taken to the nipping or smashing machine and inserted between the upper and lower platens; the pressing is rapidly and thoroughly effected by the rising and falling of the upper one. The back of the book is then "glued up" by hand to hold the sections together while the cutting or trimming of the

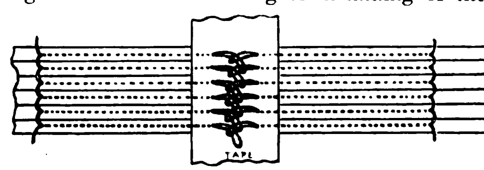

FIG. 12.

edges is performed; the back is brushed over with hot glue, which is, or should be, worked well in between the sections. Whether the edges of a book should be cut or not by the publishers' binder is a moot question; probably most librarians prefer the binder to do the work. There is an almost endless variety of cutting machines; some of them have only one knife, others have two knives, and others, again, have three. Most of the guillotines work upon a similar principle: a pile of books is correctly placed by means of a gauge on the bed of the machine; the operator starts the machine, and it automatically completes the cycle of operations; the work is clamped under heavy pressure; the knife descends, cutting one edge, and returns to its original position; the clamp releases the work, and the machine stops in order that the work may be removed. The "Duplex" trimmer is equipped with two knives which act automatically and simultaneously, and with turntables upon which two piles of

books are placed back to back. An enormous output in a short time is effected by the machines having three knives; these are respectively called the "Seybold," the "Oswego," and "August Fomm's" continuous book-trimmers. The construction of these three machines is similar, the essential features being a rotary table divided into four sections, and three knives which act simultaneously and automatically, so that at every quarter-revolution of the table a pile of books is delivered having the three edges cut. The latest machine for cutting the three edges of books, introduced by Smyth-Horne, Ltd., is a novel one, and exceedingly rapid. The operator, at intervals, feeds a handful of books to the gate of the machine; the machine itself jogs and presses the work, cuts the three edges at one operation, then unclamps the work, and discharges it into the receiving trough. For trimming books that are to have deckle edges, the Mercer continuous book-trimming machine

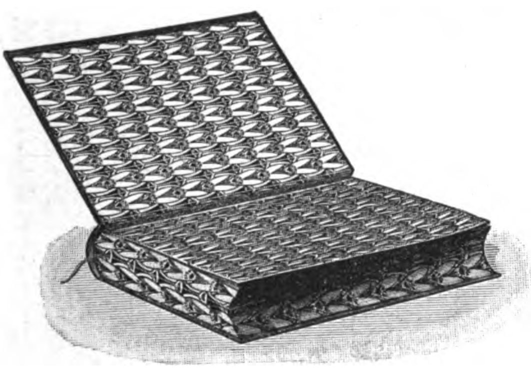

FIG. 13.

is employed; this machine has a circular knife which cuts off the projecting edges of the leaves as the books are automatically drawn against its edge by means of two horizontal endless chains.

If the edges of the book are to be decorated by gilding, colouring, or marbling, the work is done by hand at this stage of the operations. There is, however, a machine for ornamenting book-edges in imitation of marbled edges; it was brought out in 1908 by Messrs. J. G. Schelter and Giesecke, of Leipzig, and is now used in some Continental binderies. The machine is constructed on the principle of the manufacturers' well-known Phœnix platen printing-machines, and all its operations are automatic. The operator places the book on the platen, where it is secured by a clamp, and it is then carried forward to the printing surface, which has meanwhile been inked by the forme rollers; during the return motion of the platen the book is unclamped and lifted so as to allow of its being easily and quickly removed by the operator. By the use of this machine it is possible to ornament the edges in several colours, and with a design to correspond to the end-papers and binding of the book (as shown at Fig. 13), thereby giving the book a uniform finish.

The book is now rounded and backed by a rounding and backing machine. The Crawley machine rounds and backs each book by one continuous operation; the operator simply places the book between a pair of rounding rollers, and the machine does the rest of the work. The rounding and backing machines are capable of doing their work in a thorough and effective manner if they are set accurately and are manipulated by intelligent workmen, but carelessness on the part of the operators may easily ruin the folds of the sections. After the book leaves the rounding and backing machine its back should receive a second coating of glue, a strip of mull should be attached, and a strip of tough paper should be put on top of this. Unfortunately, however, the mull is frequently attached during the first glueing of the back, with the result that most of the strands on the back are severed by the rounding and backing machine, and the strength of the back lining simply depends upon the strip of paper.

While the preceding operations are being performed, the book-cover or "case" is made in another department of the bindery. The work of case-making is now done entirely by machinery. The first stage in the making of a cover is to cut the boards to the required size; this is done by a rotary cutting machine driven by power. There are two machines in general use for case-making, namely, the Sheridan case-maker and the Smyth case-maker; the construction and working of these machines are different, but they both automatically glue the cloth, apply the boards and lining, and turn in the edges of the cloth, thereby making a complete case. For the Smyth case-maker a roll of cloth must first be cut into rectangular sheets of the correct size for the cases, but for the Sheridan case-maker the ordinary roll must be cut into a roll of a width requisite to the cases, which is then fixed to the machine.

The book-cover is now ready to be lettered with its title, and to be ornamented. Cloth book-covers may be decorated in various ways —by blind stamping, embossing, blocking in gold, white or coloured foils, or alloyed metals, and printing in colour, or by a combination of some of these processes. If the cover is to be

decorated simply by blocking in blind or gold, or by printing in one colour, only a single die is necessary; but if the cover is to be decorated in gold and one or several colours, a separate die is required for the gold and each colour, unless the colours are to be blended by applying the colour in bands up and down or across the cover. For blocking in "blind" or in gold, or for printing in colour, dies or blocks cut in relief are used; for stamping in relief, a die of hardened brass cut in intaglio, and a counter die, made up of millboard, sugar-paper, or *papier-maché* are necessary. There is an enormous variety of machines for doing the work of blocking and printing. Most of the blocking presses work in similar manner: the block is fixed to an upper plate, situated under a heating-box kept at correct temperature by gas-jets; the cover, after having had the gold-leaf laid on, is placed on the lower platen, and it is then brought into contact with the die which gives the impression and fixes the gold-leaf. The superfluous gold is afterwards wiped off, leaving the ornamentation visible. Colour-work is done without heat, and frequently platen printing-presses, specially constructed for the purpose, are used. Another form of book-cover decoration in vogue is that consisting of a paper illustration, usually forming a central panel, attached to the cover which has previously been stamped to form a depression to receive the print and to protect its surface. This method is to be deprecated, because the paper illustrations soon get very shabby, and, furthermore, the book-cover should not resemble or compete with the illustrations in the book. Attention may be drawn to two other recent methods of book-cover decoration, viz., lithography and the three-colour process. The upper cover of Messrs. A. Constable and Co.'s edition of Oliver Goldsmith's "The Deserted Village," published in 1909, has an excellent reproduction of a charming rustic scene painted by W. Lee Hankey, which was effected by lithographic printing on a cloth which had been specially prepared. The pictorial design on the red cloth cover of H. Strang's "Humphrey Bold" (Henry Frowde and Hodder and Stoughton) was obtained by first blocking a portion of it in white foil, and then applying the three-colour process.

Five or even six different colours are sometimes used in printing book-covers, but more frequently the number of colours is restricted to one or two, with or without the addition of gold, which, of course, lessens the cost of production considerably, as each colour requires a separate printing. From an artistic point of view the restriction of colours is commendable, because the "painty" appearance which covers printed in several colours frequently have is avoided.

The present excellence of the designs of publishers' book-covers and end-papers is due partly to the arts and crafts movement (indelibly associated with the names of William Morris and Walter Crane), which has done so much for the practical revival of sincere design and handicraft. Within recent years a distinct school of book-cover designers has arisen, and artists in other and wider fields of decorative art, such as Walter Crane and Sir Hubert von Herkomer, have contributed their quota to book-cover decoration. There is an enormous variety in book-cover designs and end-papers which may be classified into four main groups: (1) æsthetic, (2) symbolic,

FIG. 14.—Designed by A. A. TURBAYNE.
By permission of Messrs. T. C. & E. C. Jack.

(3) heraldic, and (4) pictorial. The aim of the designer of an æsthetic book-cover is merely to create a design that will decorate with ornament the rectangular cover without any apparent connection with the subject-matter of the book. A. A. Turbayne's cover-design* for Messrs. T. C. and E. C. Jack's edition of Lamb's "Tales from Shakespeare," herein reproduced, is a beautiful example of this class. The aim of the designer of a symbolic cover is to suggest by imagery the purport of the book. Illustrations of two typical examples of this class are given. Walter Crane's felicities of design are seen to advantage

* The blocks of the cover-designs by A. A. Turbayne, W. Pogany, G. W. Eve, A. Rackham, C. E. Dawson, and J. Hassall, illustrated herein, have been kindly lent by Messrs. A. W. Penrose and Co., the proprietors of the 'Pictorial Annual."

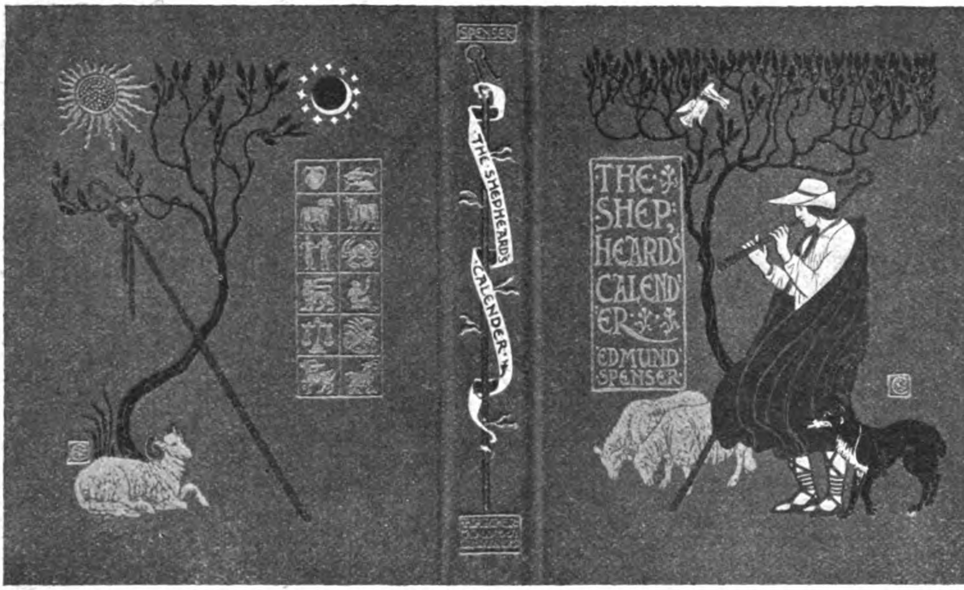

FIG. 15.—Designed by WALTER CRANE.
By permission of Messrs. Harper & Brothers.

on his cover for Spenser's famous collection of pastorals entitled "The Shepheard's Calender" (Harper and Brothers), which depicts a shepherd and his appurtenances, and the symbols of the zodiacal constellations. Willy Pogany's treatment of grape leaves and roses on the cover of Messrs. Harrap's edition of the "Rubáiyát" of Omar Khayyám is strikingly original, and effectively symbolises Fitzgerald's quatrains of the Persian astronomer-poet. A good example (see Fig. 17) of an heraldic book-cover is that of G. W. Eve's "Heraldry as Art" (B. T. Batsford), designed by the author, which depicts a lion rampant, supporting a banner bearing a Tudor rose.

Pictorial covers are very numerous on children's books, and they are also plentiful on books intended for "children of a larger growth." Pictorial designs aim to illustrate clearly the contents of books; usually a

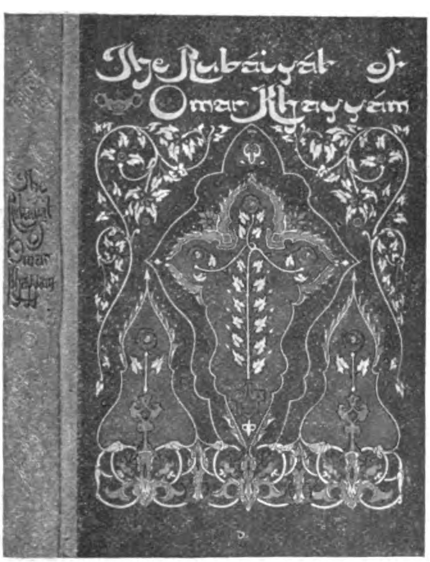

FIG. 16.—Designed by WILLY POGANY.
By permission of Messrs. G. G. Harrap & Co.

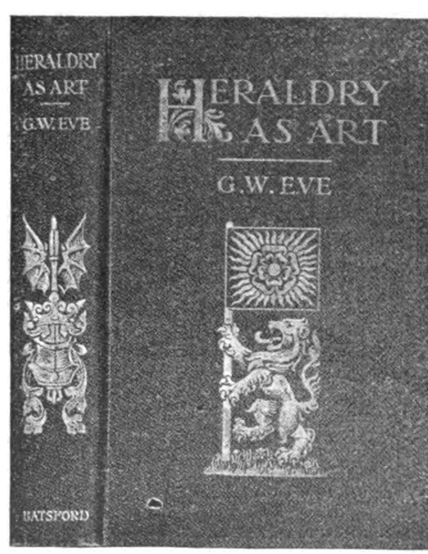

FIG. 17.—Designed by G. W. EVE.
By permission of Mr. B. T. Batsford.

pictorial cover either portrays one or more of the characters, or it illustrates an important scene in the book. Arthur Rackham's successful design for Mr. Wm. Heinemann's edition of

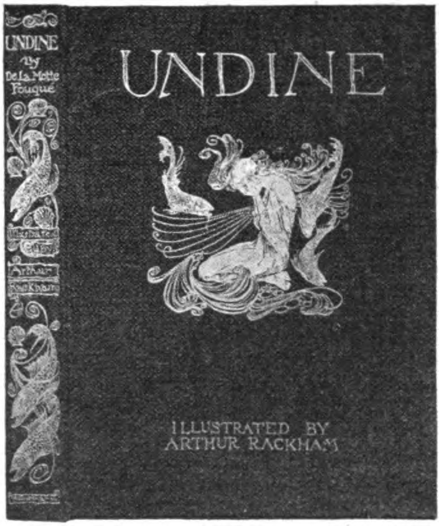

FIG. 18.—Designed by ARTHUR RACKHAM.
By permission of Mr. Wm. Heinemann.

De la Motte Fouqué's "Undine" (herein reproduced) is an excellent example of a pictorial cover; the design, blocked in gold on blue cloth, portrays the water spirit in her grief, whose name gives the book its title. Charles E. Dawson's cover-design for "Six Women" (T. W. Laurie) is illustrated herein as an example

FIG. 20.—Designed by JOHN HASSALL.
By permission of Messrs. George Allen & Sons.

of a pictorial cover, the silhouette figures of which indicate the title of the book; it is also an example of a successful colour-scheme which secures the effect of three printings by one

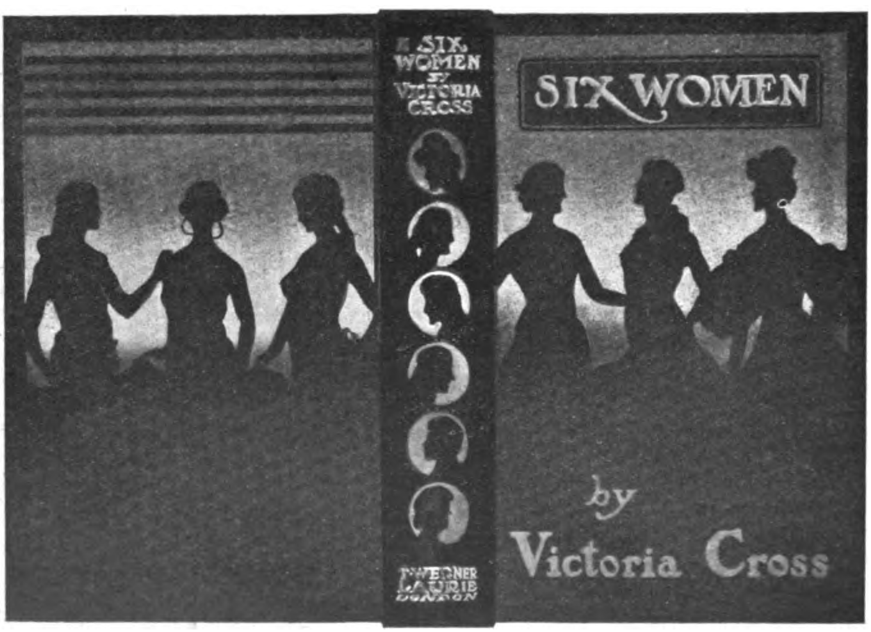

FIG. 19.—Designed by CHAS. E. DAWSON.
By permission of Mr. T. Werner Laurie.

working, the colour gradations being obtained by dividing the ink duct of the printing press. The famous "poster-man," John Hassall, has produced a large number of pictorial designs, many of which are humorous; an illustration is given of his ludicrous cover-design for "A Cockney in Arcadia" (George Allen and Sons), which cannot fail to arrest attention and arouse curiosity as to the contents of the book—the principal object of the pictorial cover.

Many decorative end-papers are specially designed for use in a particular book, and frequently they are the work of the illustrator, who also designs the book-cover, thus ensuring harmony in the decorative scheme; other end-papers are intended for a series of books, and thus, besides being decorative, serve to show the relationship of the books in a series. A familiar example of the latter class is R. L. Knowles' pleasing symbolic end-paper for Messrs. Dent's "Everyman's Library," which is admirably adapted for a comprehensive series of volumes of the great and live literature of all time; the Gothic character of the design is in keeping with the mediæval morality play from which the motto is taken, and the twirling ornament is suggestive of Fortune's wheel, amidst which is the calm, matronly figure of Wisdom, holding a branch of the tree of knowledge and the scroll of learning. Walter Crane, who considers that end-papers should not compete with the illustrations proper, but should be delicately suggestive of the character and contents of the book, is very partial to end-papers having

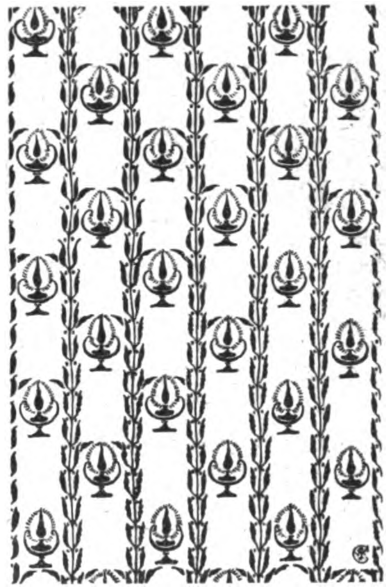

FIG. 22.—End-paper for "IDEALS IN ART." Designed by WALTER CRANE.
By permission of Messrs. George Bell & Sons.

repeating patterns. A noteworthy example of this artist's work is the end-paper for his "Ideals in Art" (George Bell and Sons), the

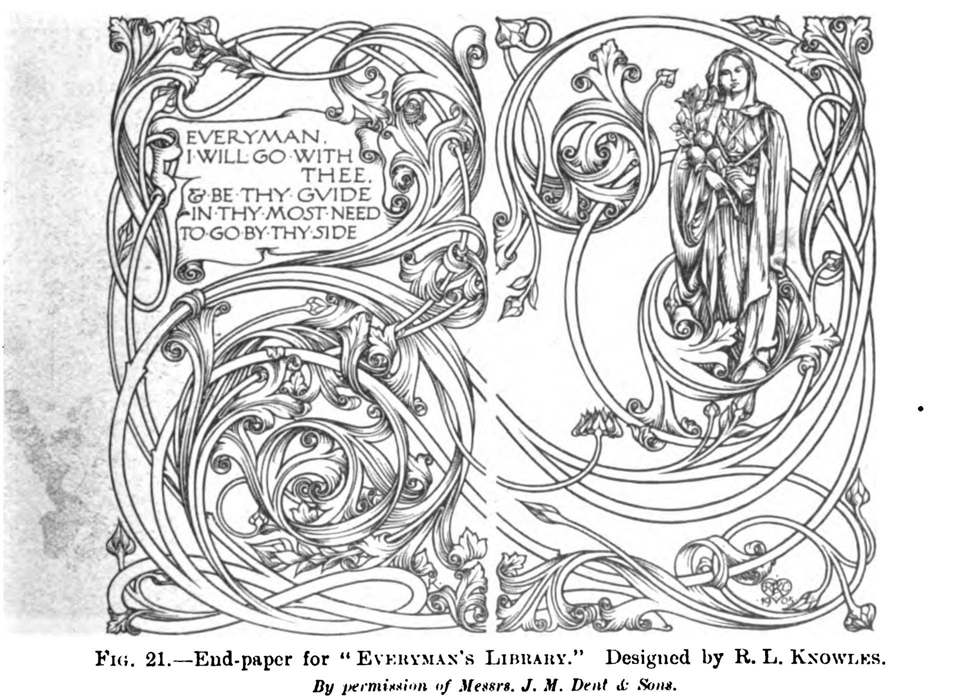

FIG. 21.—End-paper for "EVERYMAN'S LIBRARY." Designed by R. L. KNOWLES.
By permission of Messrs. J. M. Dent & Sons.

design of which (see Fig. 22) consists of vertical rows of conventional laurel leaves alternating with rows of ancient lamps. Edmund

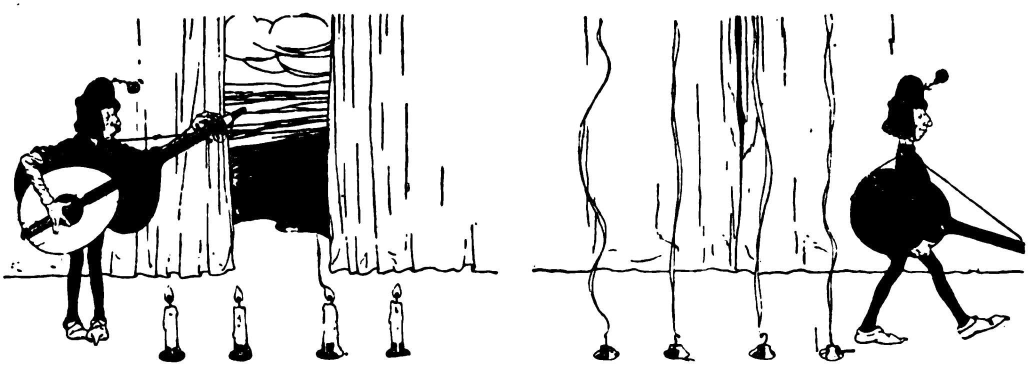

FIG. 23.—End-papers for "LYRICS: PATHETIC AND HUMOROUS." Designed by EDMUND DULAC.
By permission of Messrs. F. Warne & Co.

Dulac's "Lyrics: Pathetic and Humorous" (F. Warne and Co.), has two good end-papers (see Fig. 23), depicting a musician, grave and gay, which form an excellent introduction and conclusion to this clever nonsense book. As the love of children for pictures is insatiable, pictorial end-papers are specially appropriate for children's books. L. Leslie Brooke has successfully grouped the principal characters of some of the most popular rhymes in the "Nursery Rhyme Book" (F. Warne and Co.), edited by Andrew Lang; from the illustration of this end-paper it will be observed that the figures unmistakably suggest the verses of Tweedledum and Tweedledee, Four and Twenty Black Birds, Ride a Cock-horse, Little Jack Horner, Three Blind Mice, Little Miss Muffet, and Mother Goose.

To resume the description of edition binding. The book-cover, having been ornamented, is attached to the book by a casing-in machine.

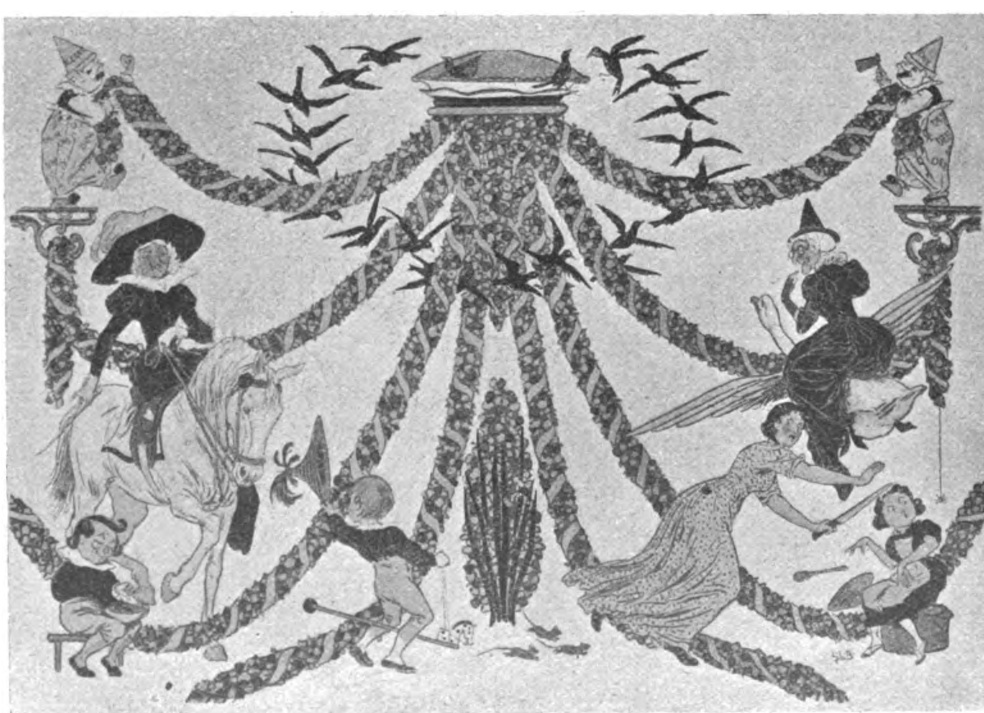

FIG. 24.—End-paper for "NURSERY RHYME BOOK." Designed by L. LESLIE BROOKE.
By permission of Messrs. F. Warne & Co.

If the Smyth machine is used, the book is placed on a radial arm which brings it into the centre of the machine; two rollers apply the paste to either side of the book; a cover is automatically placed over it and forced into the joints, and the sides are pressed before the book is removed by the operator. If the Parkside machine is used, the book is placed in a guide and pushed on to a book-blade; it is then lowered into the machine to receive a coat of paste from a pair of pasting-plates, during which time a cover has been advanced from the magazine, had its back rounded, and then been placed above the book; as the book ascends, it rises into and lifts the cover, and the cased book is then removed by the operator. As the books are removed from the casing-in machine, they are conveyed to a hydraulic standing press, in which they are stacked and pressed for several hours. Finally, the books are removed to receive their wrappers, and they are then ready for the publisher.

From the preceding account of edition binding it should be evident that machine binding has come to stay, and that satisfactory work can be done by the machines if they are permitted to work at their maximum efficiency. Unfortunately, owing to the acute stress of competition between publishers and the demand for cheap books by the public—who cannot or who will not make any distinction between immediate and ultimate advantage—the publishers are practically compelled to avail themselves of every means which tends to lessen the cost of production. The inferior physical qualities of books at the present day must not be attributed primarily to the wholesale bookbinder, as he simply estimates for that for which he is asked, and, if the prices are cut very fine, one cannot expect him to turn out good work. The responsibility lies with the publisher, who is generally more concerned with low prices than with quality and serviceability; even when he is prepared to pay a fair price for a binding* he oftentimes handicaps the binder severely by giving him books to bind that are printed on the detestable featherweight paper, or the equally execrable heavily-loaded art paper, both of which preclude the binder from doing satisfactory work. Featherweight paper cannot be sewn tightly because if much tension is imparted to the thread it would tear the paper, neither can featherweight paper be properly pressed, as this would considerably reduce the bulk of the book, and thus frustrate the publisher's object to delude book-purchasers into believing that they were receiving in exchange for their cash a book containing a large amount of reading matter. These books are generally provided with very attractive covers, as the publishers are well aware that, as in Shakespeare's time, "the world is still deceiv'd with ornament." It is sometimes facetiously suggested that a kindly Providence invented featherweight paper for modern books because the majority of them have only a slender claim to survive another generation. Whether a new book has a strong claim or not to literary merit, its worst fate, as a writer in the *Pall Mall Gazette* recently pointed out, is to carry, like a victim of cancer or consumption, the seeds of its dissolution within itself. There are hundreds of valuable books, including costly reference books, printed on inferior paper which are a standing disgrace to the publishers who issue them. The heavily-loaded art paper, which has come into vogue as a result of the extensive use of half-tone and colour blocks, is also a serious defect of modern book production for several reasons. It cannot be bound satisfactorily by the usual methods of commercial bookbinding; after a book composed of this paper has been subjected to slight usage, the surface of the paper flakes off from its meagre basis of fibre, the glue on the back of the book cracks and breaks away from the paper, and thus the whole book becomes loose, and the sections speedily break in their folds. From the readers' point of view, books printed on this paper are inconveniently heavy to handle, the paper is unpleasant to the touch, it is dazzling to the eye, and one leaf sticks to another upon the slightest application of moisture; furthermore, unless the paper experts are wrong, it is doomed to rot speedily.

So far as publishers' bindings of the present day are concerned, their defects are generally assignable to one or more of the following items:—

Materials.

1. The use of thread, tapes, cords, and mull of inferior quality.

2. Sewing or stitching with wire that is not rust-proof. (Wire-sewing is not much used in England for bookwork, but pamphlets are commonly stitched or stabbed with wire staples.)

3. The use of inferior glue or glue of the wrong consistency.

4. The use of inferior cloth which is neither fast to sunlight nor to water, and which soon becomes faded or discoloured and shabby.

* Publishers' books are "cased," not "bound," but the familiar term "binding" has been used herein instead of "casing."

5. The use of cheap metal foils instead of gold leaf.

6. The use of unsuitable blocking inks.

7. The use of white or coloured foils which easily rub off when the books are handled a few times.

Methods.

1. Sewing with thread to which insufficient tension is imparted, thereby resulting in "loose" sewing. (Of course, if the tension be too great, the thread would tear the paper and would also result in loose sewing.)

2. Sewing on the "two sheets on" principle, which considerably decreases the strength of the binding; furthermore, sections sewn by machine on this principle are usually perforated by the punching devices, as if the sections were to be sewn on the "all along" principle, so that there are several unnecessary holes in each section, which, besides being unsightly, decrease the tensile strength of the paper, and frequently allow the glue to penetrate into the middle of the sections.

3. Sewing on the "all along" principle on an insufficient number of tapes or cords, and with less than the maximum number of stitches. In some cases the tapes or cords are dispensed with, and the books simply sewn on to mull of poor quality.

4. Fixing the back lining of mull to the book prior to the rounding and backing operations. This practice frequently results in many of the strands of the mull being severed by the rounding and backing machine; and if the backing plate of this machine is not properly adjusted the paper at the folds is crushed and broken.

5. Tipping plates, maps, etc., or other single leaves with paste, instead of guarding them round the adjoining section.

6. Cutting the slips (*i.e.*, the ends of the tapes or cords) too short, and cutting the mull of a less width than is necessary to make a strong joint.

7. The defective execution of the casing-in operation. (This may either be due to the application of an insufficient quantity of paste at the joints, or to the inaccurate placing of the cover on the book.)

8. Paper illustrations and paper titles on the covers.

9. Square-backed books which cause the fore-edges to assume a convex shape.

10. General looseness of the book due to insufficient pressing in the standing press.

Some of these defects are to be found in almost all publishers' bindings, which are consequently very unsatisfactory. In a public library the average life of a publishers' binding before being repaired is about thirty issues. When deciding upon the kind of binding (apart from the decoration of the cover), publishers do not seem to take into consideration the selling price of the book, and provide a binding commensurate with it; books published at 25*s.* often have bindings no better than those on books published at 6*s.* Especially is this true of expensive scientific and technical works for which a small demand is anticipated; many of these, being translations, cost the publisher comparatively little. Presumably, a publisher estimates the probable number of copies required by public libraries and scientific bodies, bases his selling price accordingly, and depends for his profits upon sales to private individuals. To provide a flimsy binding for such books is sheer shortsightedness and stupidity on the publisher's part, because if a public library decide to purchase these books, the extra cost of a satisfactory binding would not be noticed or resented.

So far as works of fiction and cheap books generally are concerned, book-purchasers as a rule receive an adequate return for their money, and doubtless the bindings serve their purpose sufficiently well when books are only handled a few times; but the bindings are quite inefficient for service in public or school libraries. The report of the Books and Apparatus Sub-Committee to the Education Committee of the London County Council on the first day of this month is apposite:—

"We are somewhat disappointed to find that a large number of the new books do not reach the standard of excellence which would justify our recommending that they should be placed on the Council's list. This criticism applies not only to the subject-matter, but to the paper, the binding, the illustrations, and the covers. We think it would be well for the publishers to consider whether it would not be advisable to issue books bound in plain cloth covers, unobtrusive in colour, and with clear gilt lettering, rather than in covers which are gaudy in colour, inartistic in design, or which bear poor and unnecessary illustrations."

It is encouraging to note that during the past two or three years the American Library Association's Committee on Binding has succeeded in inducing several of the leading American publishers to issue some of their important and popular books in a strong binding, suitable for library requirements, at a small additional cost, generally about ten cents, and fifteen cents for some of the larger volumes.

In June, 1908, no less than 112 works in reinforced bindings prepared by different publishers were exhibited at the Annual Conference of the American Library Association, and since that date additional works have been issued; some of these bindings conform completely to the following specifications prepared by the American Library Association, while others conform in certain particulars only:—

1. The first and last signatures guarded with muslin.

2. End-sheets made of good paper and reinforced with a muslin joint to be sewed on as a signature.

3. Best quality of cotton thread to be used, and volume to be sewed on three tapes.

4. Thin strong muslin or canton flannel to be used on the back instead of the ordinary super [*i.e.*, mull].

5. Use some kind of strong buckram for a cover instead of the ordinary trade cover.

In the main the books were sewn and cased by machinery; in some cases the books were bound in a good strong buckram, while in others the cloth for the ordinary trade edition was used. The Chairman of the Binding Committee of the American Library Association, who has tested the reinforced bindings in his library, has recently informed me that he considers "there is no comparison between the durability of the good special binding and the ordinary publishers' binding." In no case had he to rebind the special bindings in buckram made by one large publisher, while other books had to be rebound because the ordinary trade cloths did not stand the hard wear to which the books were subjected, although the sewing was perfectly sound. The American publishers' reinforced bindings have given complete satisfaction to librarians. In a letter published in *Public Libraries*, the Librarian of the Jacksonville Public Library, U.S.A., stated that a copy of F. H. Smith's "Tides of Barnegat" (Charles Scribner's Sons) had circulated in his library "142 times without a single visit to the repair room." A specimen copy of this book in my possession is bound in buckram, is machine-sewn on two tapes, has end-papers with cloth joints sewn on as a section, and the title and author's name are lettered in gold on the back.

In this country three publishing firms have emulated the example of the American publishers. The firms of Henry Frowde and Hodder and Stoughton combined in 1909 for the purpose of publishing a series of "Oxford Books for Children," some of which were issued as an experiment in special library bindings of quarter pigskin and pluviusin. Considerable improvements were made in these special library bindings a few months ago, and they now possess the essential features of serviceable library bindings. The books are obtainable in quarter pigskin or morocco, and whole legal buckram or Imperial morocco cloth, and the chief characteristics of these bindings, which approximate to the usual library bindings, are as follows:—The books are bound from the sheets; the books are sewn on four or five tapes on the "all along" principle—the smaller volumes by machine, and the larger by hand; the first and last sections are lined in their folds with jaconet; the illustrations are guarded with jaconet round the adjoining section, and sewn through; the end-papers have linen joints; the books have French joints; flexible glue is used on the backs; the boards are good quality millboards with blunted corners; the books are boldly lettered in gold on the back with the title and author's name, and neatly finished with blind fillets.

The firms of Thomas Nelson and Sons, and J. M. Dent and Sons both issued, in the spring of last year, some of their publications in reinforced bindings. Messrs. Nelson's experiment consisted in issuing several of their 2*s.* net novels in a special binding at an extra cost of sixpence per copy, the special features of which are:—the book is machine-sewn with strong thread on the "all along" principle, on three tapes which are of good length; the first and last sections are lined in their outer folds with linen; the book has linen joints; the cloth is strong, and the boards are stout grey boards; and the title and author's name are boldly lettered on the back.

Messrs. Dent and Sons' venture is much more extensive, the whole of the five hundred volumes comprising their world-famous "Everyman's Library" being obtainable in two styles of library binding: (1) bound in a strong linen-faced cloth at 1*s.* 6*d.* net per volume; (2) bound in quarter pigskin at 2*s.* net per volume. The special features of these bindings are:—each book is machine-sewn with strong thread on the "all along" principle on three strong tapes; the back is rendered flexible by the use of a special glue, and the back lining of mull is of good quality; the end-papers are completely lined with mull, and they are passed round the first two and last two sections of the book; the boards are strong millboards; the title and author's name are clearly lettered on the back, and the cover is devoid of ornament.

In the provision of special library bindings for expensive works the Cambridge University Press has decided, within the last few weeks, to take the initiative; copies of the new edition of the "Encyclopædia Britannica" will be bound in half morocco in accordance with specifications prepared by the British Library Association, and in whole "Legal Buckram" in accordance with the American Library Association's specifications. The specifications of the British Library Association provide, amongst other items, for strong machine-sewing with unbleached thread on unbleached linen tapes; the guarding of plates; end-papers with cloth joints; lining the first and last sections with linen; millboards instead of strawboards; French joints; Winterbottom's "Imperial morocco cloth" fast finish; and hard grained morocco, in conformity with the Royal Society of Arts' specifications.

These pioneer efforts in the direction of serviceable publishers' bindings are greatly encouraging to the Book Production Committee of the British Library Association, which is now formulating a series of standards regarding the typography, paper, and binding of books in the hope that they will be accepted by the leading publishers as a basis on which modern book production shall be carried on. This committee has almost completed its investigations, and its report will, in all probability, be published during the present year. In the meantime I have permission to quote the committee's two provisional specifications for publishers' cased work as they are at present formulated.

Specification I.

Publishers' Cased Work Generally.

1. Books to be sewn with strong thread.
2. Books to be sewn "one sheet on" on strong tapes; at least three tapes to be used for crown octavos, four for royal octavos, and an increased number of tapes for books of larger size. Two of the tapes to be placed not more than one inch from the head and tail of book, and the slips to be of good length.

Note.—In the case of extra-thick volumes printed on thin paper it may be necessary to sew "two sheets on."

3. All single leaves and plates to be guarded round the adjoining section and sewn through. Or, when the plates are few, they may be pulled on paper with the inner margin extra wide in order to allow the paper to be folded round the adjoining section.
4. End-papers to be of good quality.
5. Flexible glue to be used in glueing up.
6. The lining to be of a strong open fabric.
7. Good quality cloth of fast colour to be used.
8. Books to be lettered on back with title and author's name at least. Ink used for the decoration of covers to be fast.

Specification II.

Publishers' Cased Work for Libraries.

1. Books to be sewn with unbleached thread.
2. Books to be sewn "one sheet on" on unbleached linen tapes; at least three tapes to be used for crown octavos, four for demy octavos, and a porportionate increase in the number of tapes for books of larger size. Two of the tapes to be placed not more than one inch from the head and tail of book, and the slips to be of good length.

Note.—In the case of extra-thick volumes printed on thin paper it may be necessary to sew "two sheets on."

3. All single leaves and plates to be guarded round the adjoining section and sewn through. Or, when the plates are few, they may be pulled on paper with the inner margin extra wide in order to allow the paper to be folded round the adjoining section.
4. The first and last sections to be guarded with linen; fine cambric for books printed on thin paper.
5. End-papers with cloth joint sewn as a separate section.
6. Flexible glue to be used in glueing up.
7. The lining to be of a strong open fabric.
8. Good quality boards with a strip of strong liner glued over the slips inside the case.
9. Good quality cloth of fast colour to be used.
10. Books to be lettered on back with title and author's name at least. Ink used for the decoration of covers to be fast.

In the opinion of the Book Production Committee the first specification represents the minimum requirements of all publishers' bindings. The second specification is presented as a statement of the requirements of books that are likely to be subjected to considerable wear in libraries; for books bound in accordance with this specification librarians would be prepared to pay an extra cost commensurate with the quality of the binding. While the general adoption of these reasonable and practicable specifications would ensure durable "cased" books which would redound to the credit of the publishers and would give satisfaction to their patrons, it should not be inferred that the bindings of such books would be the *ne plus ultra* of commercial bookbinding.

In the interest of sound book production, specifications are required for all the materials

used in commercial bookbinding, in addition to specifications for superior book-paper. The Royal Society of Arts did a great service when it appointed a committee to investigate the causes of the decay of modern leather bindings, and to indicate the best methods of preparing leather for bookbinding; and the committee's published report has had a salutary effect on the manufacture of leather, for which all librarians and bookbinders are grateful. But leather is only one of several materials which are of importance in connection with the durability of bindings. Tapes, cords, thread, glue, and cloth are all factors of prime importance in bookbinding. The Report of the Committee on Leather for Bookbinding certainly recommends the use of unbleached linen tapes and unbleached linen thread, but no reasons are offered in support of the recommendations; unbleached materials are obviously preferable to bleached ones, but it seems to be a moot point as to whether linen is superior to cotton. With regard to thread, it is questionable whether first quality cotton thread, apart from its cheapness, is more suitable than linen thread. It is true that the tensile strength of linen thread when new is much greater than that of cotton thread, but linen thread frays more readily than cotton thread. It has been seriously contended by an eminent gentleman connected with the bookbinding industry that the application of glue to the back of a book affects linen thread (and linen tapes) much more than it does cotton, and that linen thread rots and deteriorates to a considerably greater extent than does cotton thread; further, it is stated that dealers (in America, at any rate) find it impracticable to carry any considerable quantity of linen thread on their shelves, because in a very few months it becomes dry and brittle, and retains only a fraction of its original strength. Here, then, is a matter that requires investigation. Tests should be made as to the tensile and fraying strains of linen and cotton threads, and their relative tendency to become dry and brittle, and to rot under the action of glue; and specifications should be formulated as to their suitability for various classes of work.

With regard to glues used in bookbinding, it is desirable that tests should be made as to their chemical composition and their properties, and formulæ should be prepared in order that no injurious ingredients should be included that would be injurious to the thread, tapes, book-cloth or leather. The glue used on the backs of books has an important bearing on their strength and flexibility; therefore tests should be made to ascertain the affinity of glue—which should be flexible—for the various classes of book-paper, and its liability to crack.

Although there are in existence some satisfactory grades of book-cloth which are fast, or relatively fast, either to water or sunlight, these are, unfortunately, not in extensive use for publishers' work. Most of the book-cloths used for publishers' bindings are unsatisfactory; usually they are not durable, they are neither fast to water nor to sunlight, and in some instances they speedily become discoloured. The discoloration, which is most observable on certain blue cloths, does not seem to be due to exposure to sunlight; whether it is due to the kind of dyes used, the action of the glue used in attaching it to the boards, or to any chemicals in the boards, remains to be ascertained.

As book-cloth is the material most extensively used for the covering of books, it is very desirable that the various grades should conform to certain specifications, so that publishers might be in a position to select for a particular book a cloth most suited to the usage it is likely to receive. A standard and popular novel, for example, requires a more serviceable cloth than an ephemeral novel of slight popularity, and a large and heavy technical work usually requires a more durable cloth than either.

In America the Bureau of Standards made important physical and chemical tests regarding the durability of certain selected book-cloths, which resulted in the publication, in 1909, of valuable specifications. The objects of the chemical tests were (1) to determine the extent to which the samples of book-cloths submitted were subject to the attack of insects, and to ascertain, if possible, the conditions favouring or discouraging such attacks, and a means of preventing them; (2) to determine the relative liability to change of colour when exposed to light. The objects of the physical tests were to determine the following physical properties, viz., weight, thickness, number of threads per 2 cm., absorption of moisture, expansion and contraction with changes in moisture, friction when pressed together, durability with respect to folding, durability with respect to rubbing, tensile strength, and stretch. The specifications formulated as a result of these severe tests are given herein as an appendix. Already the two largest book-cloth manufacturers in America are producing cloths in accordance with these specifications; these cloths are being extensively used in America on books

that require a strong durable cloth, and they have already found favour in this country. The only adverse criticism that has been applied to these cloths is that they are not fast to water. As these specifications were originally formulated with the view of obtaining a satisfactory cloth for the binding of Government publications and reference works of a similar character, the question of fastness to water was comparatively insignificant. It is very desirable, however, that cloth on books which are carried to and from libraries in all weathers should be fast to water, in addition to being fast to sunlight. So far as I am aware, no cloths at present meet these requirements.

The standardisation of book-cloths in Great Britain is quite practicable, and it is worthy of the attention of the Royal Society of Arts. The Society could prosecute inquiries and obtain suitable materials for testing, and so forth, and it could employ the National Physical Laboratory to make the actual tests, as it possesses much of the necessary apparatus. It might be advisable to formulate three specifications for book-cloths: (1) for cheap cloth for ordinary book-work; (2) for a medium cloth for superior books; and (3) for a good cloth for library books and others that require a strong durable cloth. Similar tests to those of the Bureau of Standards might be made, but special attention should be given to the relative advantages of cotton cloths as compared with linen cloths, and to the attacks of British and foreign insects; tests should be made regarding the effects of water on the colour of the cloth, the effects of the products of combustion on the cloth, and the behaviour of the cloth in regard to germ cultures.

If the Royal Society of Arts would undertake the work herein suggested, a powerful impetus would be given to sound book production. The publishers would then have reliable standards for their guidance in the production of satisfactory books, for which librarians and others would be prepared to pay a fair compensation; the publishers would receive the cordial co-operation of the paper-maker, the printer, the manufacturers of materials, and the binder; and with this consummation British books would become renowned for their intrinsic value in addition to their artistic qualities.

[NOTE.—The paper was illustrated by an exhibition of modern commercial bookbinding, which included specimens of the binding of the *Strand Magazine* by the Sheridan "Perfect Binder," the various kinds of machine book-sewing, book-edge decoration by the Phœnix platen machine, case-making by machinery, and the blocking and colour printing of book-covers. The exhibits also comprised book-cloths made by J. Bancroft and Sons, and the Holliston Mills, in accordance with the specifications of the Bureau of Standards, Washington, U.S.A.; fast finish cloths made by the Winterbottom Book Cloth Co.; a set of blocks and book-covers to illustrate the seven stages in the decoration of the book-cover for "The Shepheard's Calender," designed by Walter Crane; specimen volumes in accordance with the Library Association's provisional specifications prepared under the supervision of Mr. Douglas Cockerell; reinforced publisher's bindings by J. M. Dent and Sons, Thomas Nelson and Sons, Henry Frowde, and Hodder and Stoughton, Charles Scribner's Sons, and the Houghton Mifflin Co., U.S.A.; specimen volumes of the special library binding for the new edition of the "Encyclopædia Britannica"; samples of flexible glue; and a collection of about 200 decorative end-papers and 200 book covers designed by English, American, and foreign artists. A number of the specimens were kindly lent by James Burn and Co., Ltd., of London and Esher.

The paper was also illustrated by lantern-slides of the principal machines used in commercial bookbinding, diagrams of various kinds of machine book-sewing, and a series of coloured slides, made by the recent process of the "Thames" Colour Plate Company, of typical book-covers and end-papers.]

APPENDIX.

SPECIFICATIONS OF THE BUREAU OF STANDARDS, U.S.A., FOR BOOK-CLOTH.

Fabric.—The fabric shall be made from first quality staple cotton, uniformly woven and of a grade known as "firsts." The weave shall be two up and two down in the warp, and one up and one down in the weft. The grey cloth shall consist of from 33–36 threads per centimeter (85–90 per inch) in the warp, and 12–15 threads per centimeter (30–38 per inch) in the weft. The surface shall be finished smooth and hard, and show no tendency to stick when folded upon itself.

Thickness, Tensile Strength and Weight.—The thickness of the finished fabric shall not exceed ·30 millimeter (0·012 inch), or be less than ·20 millimeter (0·008 inch). The tensile strength of the

grey cloth shall not be less than 18 kilograms per centimeter (100 lbs. per inch) of width in the warp, and 9 kilograms per centimeter (50 lbs. per inch) of width in the weft. The average value for the warp and weft in the finished fabric must show an increase over the average value for the warp and weft in the grey cloth of at least 10 per cent. of the strength of the grey cloth. The finished fabric, when dry, shall weigh not more than 260 grams per square meter (0·5 lb. per square yard), or less than 200 grams per square meter (0·4 lb. per yard).

Absorption of Moisture.—At a normal relative air humidity of 65 per cent. it shall not absorb more than 5 per cent. of moisture, or expand (an average of both directions) to exceed ·45 per cent., and when subjected in a closed case to a saturated atmosphere for two hours, at a temperature of 20° C. (68° F.), shall not absorb more than 10 per cent. of moisture, or expand (an average of both directions) to exceed 2 per cent. All increases to be computed on the basis of the dry weight and dimensions.

Folding Endurance.—The folding endurance as determined by the Schopper folder shall be not less than 65,000 double folds for the warp, and not less than 10,000 for the weft.

Colour.—Before coating, the fabric must be dyed with a purely mineral or inorganic colour (such as iron salts), so as to imitate the colour of the finished cloth, but somewhat lighter in shade, so as to give the desired "linen" effect. All coal-tar, aniline, vegetable, or other organic dyes and lakes, must be strictly excluded from both fabric and coating, even in traces. The following substances must be also excluded: Chrome yellow and other chromates, ultramarine, browns containing bituminous or other organic matter, compounds of lead and arsenic. The colour of the finished fabric should be slightly darker than the standard sample, which will be furnished on application, and it must not show the slightest change of colour after exposure under prescribed conditions to direct sunlight, or to the action of ammonia gas, sulphuretted-hydrogen gas, sulphur-dioxide gas, or illuminating gas.

Resistance to Mould and Insects.—The finished fabric shall be immune to the growth of mould or the attack of insects.

NOTE.—For the present some latitude will be allowed in the enforcement of this requirement, since definite knowledge of the causes and the methods of prevention are still lacking. Experiments have shown that book cloths have been produced which meet the requirements.

Tests.—Physical and chemical tests to verify the properties required by these specifications will be made according to the standard methods for testing book cloths as used by the Bureau of Standards, copies of which can be obtained on application.

DISCUSSION.

The CHAIRMAN (Mr. John Murray), in opening the discussion, said that though he had not actually bound a book with his own hands, he had been responsible for a very great deal of binding, and therefore the subject was of intense personal interest to him. The more one heard of the shortcomings to which Mr. Stephen had referred, the more one felt that the two points of view from which the subject might be considered, namely, that of the book-lover and the book-user, were widely different. Those who were book-lovers must have felt, in looking at some of the old bindings with studs and ornamental silver plates, that though they were works of art in themselves, they were absolutely inappropriate for books. A book in its normal state was not to be laid on a table, or put in a bookseller's shop, but it should be put on a shelf along with other loved and cherished friends, and books bound in the rough, unkindly bindings to which he had referred were almost impossible for that purpose. He had in his collection one or two of the old chained books, which were a constant source of anxiety, because they had to be kept by themselves; otherwise their neighbours suffered from their contact. One point in regard to the beauty of binding which the author had not touched upon was that the first requisite in a book which could be admired inside and outside was the imposition of the text. He had seen ostensibly beautiful books which were entirely spoiled from faults of that kind. In considering, as a publisher, the question whether books should have cut edges or not, it was necessary to take into consideration that question, because if the book was a good book issued in a cloth binding, many book-lovers would in due course have it bound in leather, when the head had to be cut a second time; if this was done a trifle too much, the book was spoiled for ever. He had some first editions of Shakespeare in which the head had been so cut that the title at the top of the page was half cut away, and in handling these books he felt this almost like a hurt to himself. Years ago, when his father issued one of Darwin's works, at the time when the question was first discussed as to whether the edges should be cut or not, although many thousand copies were subscribed for, he did not think 10 per cent. were ordered with cut edges. In those days it was the fashion to have books uncut. A man who loved a book liked to cut the edges with a paper-knife and to look at the rough edges, the thought being present in his mind that some day the book would be bound according to his own taste. But people at present lived in a hasty age, and very few of them were in favour of the uncut edge. The author had very properly criticised the publishers, who generally were held responsible for much that they had not done. Personally he should feel sorry if, in a discussion upon books, the publishers did not come in for their full share of blame, because he was so accustomed to it that he

rather liked it. The publishers were accused of being responsible for bad bindings, for a certain amount of stupidity, and for a desire to delude book-purchasers. He assured the audience that cheap bindings were a grievous necessity, although it was heart-rending to the publishers. If publishers tried to turn out a book well on the best paper, with the best binding, they got no thanks for it; the public did not appreciate it. We were living in an age when there was a craze for cheapness. It was no doubt an excellent maxim that people should buy in the cheapest market, but the other essential, inseparable condition must not be lost sight of, that it was sometimes wise to sell in the dearest market, and by buying in the cheapest market the selling market might be altogether lost. Books were put on the market at such a price that some publishers did not care to turn out such cheap work. He was interested to hear from the author that the London County Council had complained of the standard at present adopted in regard to the paper and binding of a large number of new books; but the L.C.C. were in a great measure responsible, for if the publishers raised the price of the books the authorities would not look at them. He strongly contended that it was the force of public opinion nowadays which compelled the bindings to be cheap. The criticism which he had made as to the unsuitability of bindings covered with nails or silver applied to some of the beautiful designs of books at present produced. To book-lovers the normal and proper position of a book was on a shelf, and not on a table, and a pictorial lithographed side was, to his mind, utterly out of place. It was only an advertisement, which might show up very well in a bookseller's shop, but personally he felt inclined to have a book rebound which had a picture on its side. Some very beautiful, startling and realistic designs had been produced, but he felt that for real beauty of design something was required which was not realistic but which was conventional. For instance, there were the beautiful designs displayed in the British Museum; and above all there was the magnificent book which was issued to the public some years ago of the bindings in the Royal Library at Windsor, from which it would be seen that binding, like printing, began at its very zenith. Publishers could not nowadays compete with Caxton or Sweynheim and Pannertz. Those people used better materials; they cherished their art; they turned out everything almost like an old missal manuscript, the very best work being put into it; and the paper 400 years afterwards was almost as good as the day it was turned out of the mill. A book-lover handled such a book with the feeling that it was a treasure. But nowadays the public did not appreciate that sort of work; books were looked upon, not as articles to be treasured, but as things to be used and thrown aside. With regard to wire binding, he altogether abhorred its use for books. It could be used very well for a pamphlet which was thrown away after it was read, but to use it for binding books was, he thought, wrong. He was delighted to hear Mr. Stephen's statements with regard to books standing wear and tear so well. From experience, he thought everyone would agree that schoolboys were pretty hard on books, but the books which had to stand the roughest and hardest wear were those which were placed in the hands of choir-boys. He was the first to advise the binding of hymn-books with pigskin backs and cloth and leather sides and corners, because that was the strongest form of binding in existence. For durable leather bindings Russia leather should, in particular, be eschewed; in fact, very few leathers could be used for this purpose.

Mr. W. E. Doubleday stated that among the defects of modern bookbinding to which the author had not referred was the glazed cloth, the surface of which got into a sticky condition, so that when a person handled the book the imprint of his fingers remained on it for ever afterwards. Part of the responsibility for the present defects in bookbinding rested with the public, because they were not prepared to pay for the improvements which might be effected at very little extra cost; and part of the responsibility rested with the publishers, who had a habit of charging quite out of proportion for the cost of any improvements which were effected. For instance, the prices asked for the cloth cases which the publishers produced for binding works which had appeared in serial form, were sometimes more than the amount charged by a bookbinder for binding the book in sound leather in accordance with the recommendations of the Royal Society of Arts. If the publishers would have the courage to adopt a superior form of binding, he thought they would find the public ready to respond to any moderate charge which might be made for the improvement. If, on the other hand, the price was altogether out of proportion, the undertaking was foredoomed to failure. As a book-lover and librarian he wished to call attention to the abominable character of some of the paper used in the production of books, particularly the spongy paper—the most difficult of all forms with which the binder had to deal. One London firm published nearly all its books upon spongy paper, the books being very tightly bound in cloth; and the life of those books, so far as that binding was concerned, was over after the books had gone out six or seven times. He hoped the publishers would not continue the use of such wood-pulp papers, as binders assured him that it was physically impossible to bind soundly a book made with that particular paper, because there was no substance for holding the thread. With regard to the question of printing imposition, he wished to utter a note of warning with regard to mechanical type-setting, which was coming more and more into practice. Part of the trouble might be due to the paper, but he knew of many books in which the mechanically-set type was a source of constant irritation to the eye. He hoped some improvement would be

effected, so that mechanically-set type might more closely resemble the hand-set type, of which it was a very imperfect imitation. He hoped that, as a result of the meeting, the Society would take up the question of the improvement of the physical appearance of books and the life of books as it had taken up the leather question. If it did so, he believed the attention not only of librarians but of the public would be directed to the question; and if a fair appeal was made to the public he thought they would surprise Mr. Murray by the response they were willing to make to an improvement at a reasonable price.

Sir GEORGE BIRDWOOD, K.C.I.E., regretted that the author did not in the earlier part of his paper condemn illustrated backs, which were very wonderful in their technical aspects, but from an artistic point of view were simply detestable. Bookbinding should be as plain as possible, and of all forms of bookbinding he preferred the old tree-calf or the mottled-calf. It was a great pleasure to him to hear the Chairman agree with the criticisms of the author in regard to the defects of the cheaper processes of bookbinding. As a botanist and medical man who had practised a great deal in India, he thought he could explain why cotton thread lasted better than linen. Cotton fibre was hollow, while linen fibre was solid. Linen fibre did not absorb moisture; the moisture clung to the outside of linen and tended to rot it very rapidly. Cotton fibre and cotton clothing absorbed a great deal of moisture, and the natives of India wore cotton clothing exclusively, unless they wore silk, and therefore they never caught cold. It was the English people, who wore linen and woollen underclothing, that always caught cold. He thought the demand of the public for cheap books could be met, not only in the way indicated by the last speaker, but also by following the French method of publishing books. The French publishers issued books in two forms—the first in a paper wrapper, and the second in superior kinds of leather bindings, at different prices. They secured themselves against loss by communicating with every likely subscriber for the purpose of ascertaining in what form he would like the book bound before it was passed through the press. There was a large public in this country who would buy good books and pay for good bindings, and the publisher could guard himself, at any rate to some extent, against any risk by adopting the French plan, which, it seemed extraordinary to him, was not more known in this country.

Mr. R. A. PEDDIE said that after carefully considering, not only the author's works but other information, it was very difficult indeed to fix the responsibility for the condition of the modern book. In his opinion, books might be divided into two classes: firstly, the cheap books, with regard to which decent condition of production could not be expected; and, in the second place, the books published ranging in price from 12*s*. 6*d*. to 25*s*. The latter class of books had, he was sorry to say, very little more care expended on them than the cheaper books, and it was that class of books which librarians expected to have put before them in a satisfactory condition. A technical book, which was published a little time ago on a particular phase of book production, reached one library in such a state that the pages were only held together by a thread here and there. The book was sent back to the publishers, with the request that a decently-bound copy should be forwarded, and a special copy was bound and sent to the library. That sort of thing unfortunately was continually coming to his notice. It must also be borne in mind that the cost of the more important books was increasing and not decreasing. In a particular book which had been published over a series of years, and of which several volumes of equal size had now appeared, each succeeding volume had been slightly higher in price than the preceding volume. The price was very high to begin with, and he did not think any slight rise that might have taken place in the cost of the materials could justify the increase. He wished to emphasise the author's remarks with regard to book-cloth. Many of those present would recollect the firm of Bentley, which many years ago published a series of novels called the "Standard Library," bound in dark-green cloth, with no ornamentation and perfectly plain lettering on the back. The cloth was of good texture and a thoroughly solid material. On inquiring from a representative of a firm of book-cloth manufacturers whether such a cloth was now produced, he replied, "No, we are never asked for it." That was the secret of the whole thing; the book-cloth manufacturers were prepared to produce the material, but they were never asked for it. Buyers of books ought to insist that books for which they paid the same price as in days gone by should be produced under the old conditions. The ordinary book of the 'sixties or 'seventies was properly sewn; was made of good paper, and not of mechanical wood-pulp paper, and after it had been used for a reasonable length of time was in good condition; but he very much doubted whether a book produced according to ordinary modern methods would be seen in such a condition twenty or thirty years hence. It would be falling to pieces, the back would be off, the cloth would be spotted all over, and it would be rotten from one cover to the other. When publishers charged such high prices for books, he thought they might reasonably be expected to consider the question of putting a little of the price into the book itself, because modern expensive books were not got up in a style commensurate with the price paid for them. The harmony of a German book with its cover was much better thought out than any book that was ornamented and produced in England on a similar basis. Germans did not use the staring reds, violets, and blues that were seen in English books. The majority of English publishers bound the

greater portion of their books in red because it was the colour that attracted, but unfortunately it was the one colour which was not fast. On the other hand, the German publisher used a cloth of good texture, and the whole book was produced in a workmanlike fashion. He would like to see English publishers adopt what was good from the German school, and harmonize it with the best practice of the English school. Although he agreed with the author's remarks with regard to wire sewing, there was one point in its favour, namely, that Baedeker's Guide Books, which received the hardest possible usage, were sewn with wire, and it seemed to be particularly effective for that class of book, because it was a very rare thing to find a Baedeker with loose leaves, unless it was an old copy.

Mr. G. A. Stephen, in reply, after thanking the audience for the kind manner in which they had received his paper, and tendering his thanks to the Chairman for presiding over the meeting and for the valuable remarks he had contributed to the discussion, said that although he had shown some typical specimens of the exceedingly ornate book-covers of the present day, he was very careful not to commend the practice. He simply showed them as illustrations of modern bookbinding. In regard to Mr. Peddie's remarks, he thought the publisher probably paid the binder as much at the present time for the binding of the book as he did formerly, but unfortunately an undue proportion of the amount went in payments for the design and decoration of the cover. The artist obtained his fee; blocks had to be cut for the reproduction of the design, which was exceedingly costly, and the binding proper suffered thereby. Mr. Doubleday had disagreed with his (the author's) statement that the average life of a book in a publisher's cover was thirty issues. He agreed with Mr. Doubleday's criticism, but he had purposely placed that figure high in the paper. Some books tumbled to pieces after being issued five or six times, but he thought it was unfair to press the point unduly, and therefore considered that thirty issues were sufficient to rub into the publishers at the present time. The meeting was indebted to Sir George Birdwood for his interesting remarks on cotton and linen, which might supply the reason for the superiority of cotton thread in certain classes of commercial bookbinding. He did not think, however, the French method of publishing books would be acceptable in this country, because there were many more public libraries in England than in France, and it would be exceedingly costly for libraries to buy their books in paper covers and have to pay 1*s*. 3*d*. or 1*s*. 6*d*. to get them bound before they could be put into circulation. In addition to that, it would prevent books being put as quickly into circulation as was at present the case; a month or six weeks' delay would probably result. Mr. Peddie had spoken somewhat favourably of the wire-sewing of Baedeker's Guides, but it must be borne in mind that those books had very little rounding and backing, and the covers were very thin and pliable. He had examined some large German books in the Patent Office Library, and found that the wire made the books so unwieldy that when they were backed in the machine there were quite a number of ugly creases in the folds.

The Chairman, in proposing a hearty vote of thanks to the author for his interesting and instructive paper, said the exchange of views which had taken place would be most useful and advantageous, and if only a little could be done to induce the public to appreciate good materials in the making, binding, and illustration of a book, as well as in the text, the paper would not have been in vain.

The resolution of thanks was carried unanimously and the meeting terminated.

ARTS AND CRAFTS.

A London School of Arts and Crafts. — The Camberwell School of Arts and Crafts usually holds its annual exhibition at about this time of year, and it is always an interesting event. The show which is now open at the South London Art Gallery in the Peckham-road, and will remain on view until nearly the end of the month, is, of course, not very widely different from its predecessors, but it is none the less very well worth a visit, not only because the work in some departments is in itself deserving of attention, but because the exhibits as a whole give a very good idea of what an up-to-date school of arts and crafts in London does and does not do. It is, from the first, quite plain that it does not do very much in the way of teaching design for manufacture. It is true there are a few pattern-designs on the walls, but they form on the whole one of the least satisfactory features of the exhibition. There is nothing which strikes one as really first-rate (even for students' work), and the patterns as a whole show no very firm grasp of the principles of the subject. The tendency is to make everything all-overish and featureless; and the value of plain spaces, in helping to give at once distinction to a design and rest to the eye, is not by any means generally understood. It may be that design pure and simple cannot be expected to take a very prominent place in a "School of Arts and Crafts," but it seems a pity that a subject which so vitally affects some of the largest industries of the country should not be more popular with the students in the schools of the Metropolis.

The largest and most important group of exhibits is doubtless to be found in the embroidery section, in which a quantity of good and interesting work is to be seen. It includes some very delicate small pieces of work and a good deal of crewel-work in which patterned background

fillings have been employed to good purpose. Some of the designs are quite sufficiently good for their purpose, but in a few cases it is difficult not to think that the student would have been better employed in carrying out a good design by someone else than in executing her own very feeble pattern. It is really waste of labour to expend good needle-work on a bad design, and, though, theoretically, it may be an admirable plan to make students work from their own patterns, the fact remains that quite a number of capable needle-women are by no manner of means designers. There are several pieces of white linen cutwork on which the stitchery is in colours. The effect of this is extremely pleasing, and it leads to very delicate colour schemes. The one or two pieces in which lines of gold thread are added to the coloured stitching are also very effective, but gold thread hardly seems a good material to employ on white linen. Much of the work in type-setting is very satisfactory, both tasteful and restrained. The students have, however, not unnaturally, been much more successful in displaying short titles than in setting up prospectuses and the like containing a great deal of matter. The examples of script and lettering are rather larger in scale than usual, but they are almost without exception well done. It seems rather a pity, however, that the student who elected to write a piece of German should not have chosen a more appropriate form of lettering. The bookbinding, as usual, is very good, and the practice of inlaying in sufficiently large pieces really to affect the design and colour scheme of the cover forms a conspicuous feature in the collection of bindings, which includes also some very good work in blind tooling. There are some workmanlike pieces of plastering, and quite a collection of pots, vases, panels, and windows in simple ornamental leadwork. The cabinet work is tasteful and characterised by a pretty use of small inlay. The drawers, etc., are fastened up so that it is impossible to tell how they run, but they look as if they fitted extremely well. The woodcarving, too, is better this year than it has been before. There is nothing very interesting in the way of stained glass, but the work of the students in the decorating and sign-painting classes is on the whole very promising. Of metalwork on a large scale there is not very much to be seen, but one or two cases of jewellery are on show. The simple work is, some of it, very pretty, but the more ambitious pieces are sometimes rather lacking in accomplishment. The enamel is extremely good. The students seem to be taught to aim at certain definite results, and not to be satisfied with anything short of them. Not only is the more elementary work satisfactory, but the really elaborate picture plaques seem generally to be very successful, and the work throughout is characterised by an appreciation of those qualities which enamel is best fitted to give. To sum up, the work on view at Camberwell, though some of it might be better, is on the whole quite as good as schoolwork can be expected to be. If the lines on which it runs are somewhat too widely divergent from those of the big industries of the country, though the fact is to be deplored, that can hardly be laid to the charge of the students, or even of the teachers of this particular school. The fault, if fault there be, goes farther back.

Women's Craftwork.—Only one room is devoted to craftwork at the exhibition of the Society of Women Artists, and it would be manifestly unfair to judge the merits of an exhibition by a small proportion of the work shown; but as regards the particular kind of art with which these Notes are concerned, it cannot be said that the exhibits at Suffolk-street make one feel that there is any particular reason why women's work wants showing apart from men's. The objects on view certainly do not, as a whole, reach so high a standard as a good deal that is to be seen at places where the work both of men and of women is shown. If one did not know better, the natural inference to draw from this exhibition would be that, except in so far as jewellery was concerned, woman's work in the artistic crafts was almost a negligible quantity. Of jewellery there really is a representative show, and if it does not include any strikingly great work, there is a fair amount that is quite creditable. A good number of women jewellers send work, and the list of exhibitors includes such well-known workers as Mrs. E. Roscoe Mullins, Miss L. Rimmington, and Miss Ethel Virtue. But the exhibition, taken as a whole, fails to justify itself on the arts and crafts side. There are several places in London where equally good work can be seen without going to a special exhibition, and it seems a pity that, if women are going to exhibit as women, they do not take care to get together a collection of objects which will give the public some sort of idea of what good work they are doing. Those of us who know what is being done realise that women form a very important section of the craft-workers of the present day; the ordinary visitor to Suffolk-street might well come away with the idea that their work was about fit for a bazaar.

Truth in Craftsmanship.—The first lecture of a course by various well-known men on the arts connected with building was delivered at Carpenters' Hall on January 25th by Mr. Raffles Davison, who took as his subject, "Truth in Craftsmanship." The lecturer showed by his slides that his sympathies were considerably wider than some of his utterances would have led his audience to expect. And, with two of his contentions, he really went to the root of a good deal that is amiss with the art of the present day. He maintained first, that the truth which we are to look for in artistic work of all kinds is *truth as seen by the artist*, not the purely mechanical truth of a photograph; secondly, that all affectation is contrary to real truth in craftsmanship. The first truth is one which, perhaps, at the present day needs emphasising more in the sphere of pictorial art than of artistic craftsmanship; but when we

come to "affectation," as Mr. Raffles Davison understands it—the affectation which refuses to use modern tools and improvements, and expects to be patted on the back in consequence—we feel that craftsmanship is the main offender. It is true, indeed, that, at any rate so far as a large section of the workers are concerned, the tendency to extol only archaic work has passed away, but there remains a large body of people who look askance at anything not produced as it was some hundreds of years ago; and undoubtedly this demand for affectedly elementary craftsmanship does help to produce a want of sincerity. Let people do simple work, by all means, and plenty of it, but do not let them fall into the error of supposing that accomplishment counts for nothing, or that, however simple the work in hand may be, anything is lost by employing modern methods when they help towards its perfection.

EMPIRE NOTES.

Cotton Growing within the Empire.—In a paper read before the Royal Geographical Society by Mr. T. Howard Reed a few weeks ago, he gives an account of the work of the British Cotton Growing Association, and shows that their statement, that "cotton can be grown within the Empire on a large scale and on a commercial basis" is fully proved. Four districts were specially selected by the Association for demonstration—Nigeria, Uganda, Nyasaland, and the West Indies. The reports of the progress of cotton cultivation in the West Indies are very encouraging. The cotton grown is mainly that known as "sea-island," which has been reintroduced from the islands off the coast of South Carolina. But other varieties are also being cultivated to advantage. Africa, however, affords the most promising field for the cultivation of the variety of cotton most in demand in this country. This especially applies to West Africa, where there are large areas of land possessing a soil and climate specially suited for the purpose, where, indeed, an extensive native industry has been carried on for centuries. On the other side of the continent, in Nyasaland, the first experiments were made in 1901-2. By August of last year the cultivation was said to be "going ahead by leaps and bounds." Uganda also is proving a most promising field. Some difficulties were met with at first, due to the ignorance and inexperience of the natives, but, under careful instruction, these have been overcome, and now, according to Sir Hesketh Bell, the late High Commissioner, Uganda may become "one of the greatest cotton-fields in the Empire." But these are not the only British lands where cotton can be profitably grown, and where efforts for its cultivation are being made. In South Africa, and particularly Rhodesia, good samples are being grown, and, in the latter country, special attention is being given to the subject by the British South Africa Company and the Association. India and Ceylon, which, at present, produce large quantities of short-fibred native cotton, can grow better qualities, and, by Governmental assistance and instruction, efforts to this end are being made, which are likely to result in a large increase of the supplies available from these countries. Australia, also, and New Guinea can grow cotton of good quality, while Borneo, Fiji, the Straits Settlements, the Malay States, the Seychelles, Mauritius, Cyprus, the Maltese islands, and St. Helena, may all become producers. And all are needed, if the requirements of our own trade are to be met within the Empire. To keep pace with our present demand, three and a quarter million bales of raw cotton, each of 500 lbs. weight, are wanted every year. To meet this demand, the continued efforts of the British Cotton Growing Association and the various colonial governments, during eight years, have only succeeded in producing one hundred thousand bales of 400 lbs. each, or one thirty-fourth of the yearly requirements of our Lancashire mills.

Forestry in New South Wales.—Profiting by the example of older countries, the Australian States are doing their utmost to preserve the forest wealth in their possession, before it becomes too late, and to turn the reserves into sources of regular income. The Forestry Department of New South Wales is doing excellent work, as the latest report shows. Since the inauguration of forestry administration in 1877, there has been a total revenue of £703,343 and a total expenditure of £469,653. There was a deficit of £48,274 on the administration up to the end of 1896, and a surplus of £233,690 for the thirteen and a half years ending June 30th, 1910. The Forest Act, which became law in February, 1910, was the first New South Wales measure to deal exclusively with the question of forestry. It promises, says the report, to be a useful working Act, but its principles will have, in time, to be extended, particularly in the direction of larger control over State forests, and in relation to such questions as their leasing and occupation. The total area, included in reserves for the preservation of timber, is now 7,690,771 acres, showing an increase of 216,511 acres in comparison with the figures of 1909. Of this area, about 4,500,000 acres have already been examined, reported on, and scheduled, for permanent retention, under a scheme of classification, and steps are being taken to review further areas comprised in the reservations, with a view to their dedication as State forests, under the Act. Figures furnished by the Customs and Excise Office show that the value of timber imports exceeded that of exports by about £632,000. Altogether £789,701 worth of timber was imported; £704,091 from oversea countries, and £85,610 from other Australian States. The value of the oversea exports of timber, dressed and undressed, amounted to £247,428; and of rough timber to £222,620. The report states that a year of great activity in the timber industry is expected. There are 420 saw-mills at work in the State, which employ 4,465 hands.

Canadian Progress.—The Minister of the Interior at Ottawa has issued a report embodying the following statistics concerning recent progress made in the Dominion. The value of the gold and silver production of 1910 is calculated at over £5,300,000, as compared with £4,700,000 in 1909. The value of last year's bond issues amounts to £46,300,000. This figure includes £14,000,000 issued on behalf of railways. It is interesting to note that 81 per cent. of the aggregate amount of these various issues found a market in Great Britain. No less than 600 million feet of lumber were cut in Ontario alone during the past year. Canadian trade has increased 88 per cent. during the last decade, which compares favourably with the percentage increase in the trade of the United States and Great Britain in the same period, viz., 55 and 38 per cent. respectively.

The Webster Claim in New Zealand.—A notable visitor to this country from New Zealand this year will be the Hon. J. G. Findlay, Attorney-General and Minister of Justice. His visit is in connection with certain Crown cases. The most important of these, and, at the same time, the most interesting, is the famous Webster Claim for £500,000. The history of this claim is quite romantic, originating as far back as 1840. The claimant, Webster, was a citizen of the United States who went to New Zealand and settled at Herekino, on the shores of the Hauraki Gulf. He appears to have been a man gifted with considerable foresight, and seeing, with the advance of settlement, the inevitable rise in land values, he turned his attention to the acquisition of land. By bartering quantities of blankets, fish-hooks, trousers, shirts and tobacco, with the Maori chiefs for land, he became the possessor of a large amount of property. By the Hobson Commission his claim to native lands, beyond a very small area, became void. It was and is maintained, however, that, being a citizen of the United States, the British Crown had no right to dispossess him. The United States Government have taken the matter up, and the case is to be argued before a specially-constituted tribunal agreed upon by the English and American authorities.

A Burmese University.—Education has been making great progress throughout India during the past few years, and many excellent colleges have been established. A Bill has now been introduced by the Burmese Educational Syndicate for the foundation of a university in Burma. The matter has already been brought before the local Government, and will shortly be referred to the Indian Government for its sanction and approval. The university will take as a model the system of the newer universities of this country. It is proposed that the Rangoon College shall form the nucleus; the Baptist College and other future colleges forming an integral part.

NOTES ON BOOKS.

Fables and Fairy Tales for Little Folk. By Mary and Newman Tremearne. Cambridge: W. Heffer & Sons, Ltd. 2*s*. 6*d*. net.

It has been Captain Tremearne's fortune to spend many years in the service of his country in parts of Central Africa where other white men have seldom or never penetrated, and he has used his opportunities to make the most careful study of the people under his sway. Among other subjects, mainly of an anthropological interest, he has devoted much attention to the folk-lore of Hausaland, and he has collected from the natives themselves a very large number of stories, of which some have been published in this *Journal* and some in *Folk-Lore*. In the present volume we have a dozen tales told in the simplest of language, and, though they are related as merely fairy tales, they have a certain anthropological value. All sorts of animals converse together, as in the days of Æsop—lions, hyænas, elephants, hippopotami, and a curious creature—a half-man, bisected vertically in such a way that he has only one arm, one leg, half a head and half a body—whom we do not remember to have met before. Captain and Mrs. Tremearne have done their work well, and the book ought to prove popular with the children for whom it is intended.

Materials of the Painter's Craft. By A. P. Laurie, M.A., D.Sc. London and Edinburgh: T. N. Foulis. 6*s*. net.

The first six of the fourteen chapters into which this book is divided are devoted to the consideration of the methods of painting in ancient times and up to the dawn of the Christian era. Dr. Laurie concludes (mainly from the statements of Pliny) that two distinct methods of painting were employed in classical times, one of which was the "encaustic" process, in which beeswax formed the medium. The methods of this encaustic painting he explains in detail, and some admirable illustrations of modern work executed according to this ancient method accompany the text.

Polygnotus appears to have been one of the first painters to use encaustic technique, and it is a matter of great regret that when the ruins of Delphi were explored no trace of the celebrated paintings by this worker were discovered; otherwise much valuable information as to the methods and durability of encaustic painting might possibly have been gleaned.

Leaving the debatable ground of classical painting, the author passes, in Chapters VII. and VIII., to the history of mural painting. All the literary evidence available, in the manuscripts of Pliny, Vitruvius, Cennini, Theophilus, and other writers, is carefully reviewed and commented upon, and compared with the opinions formed by various workers as the result of scientific examination of specimens. Dr. Laurie comes to the conclusion that there was a distinct difference between the

technique of fresco painting employed in early times and that practised by the mediæval craftsmen.

In the two following chapters the manuscripts of Theophilus and Cennini are respectively discussed, and then, after an all too brief chapter on "Illuminated Manuscripts," which scarcely does justice to the subject, we come to the most valuable part of the book, in which the author puts together and amplifies in the light of further investigations his classic researches on "The Pigments and Vehicles of the Old Masters." This subject is dealt with in three lengthy chapters, in the first of which, "On the Preparation of the Lakes used by the Old Masters," we see how the various organic pigments were developed from the first crude infusion of dye-stuffs used in early times. The various materials from which lakes are prepared are considered in detail, and the author quotes some interesting experiments of his own on the preparation of lakes according to the recipes given in the manuscripts of Cennini and others.

We then come to a chapter "On the Nature and History of Varnishes," in which the probable method of production of mediæval varnishes is investigated. Literary evidence by itself, as the author points out, is practically worthless on this point, owing to the confusion of nomenclature; but, applying the results of careful experiments to the elucidation of such receipts as occur in the old manuscripts, he comes to the general conclusion that the ordinary varnish used until late in the fifteenth century "consisted of a fairly soluble resin—sandarac or mastic—dissolved in linseed oil, with the addition in many cases of a considerable quantity of pica greca (resin)"; and that the use of volatile solvents and balsams did not come in until the sixteenth century.

The last chapter, on "The History of the Oil Medium," contains a large amount of practical information and pertinent suggestion of which no summary can be attempted in the space at our disposal. The author has here a great deal to say on that much-debated question, the nature of the medium used by the Van Eycks in the preparation of their works, and in discussing it he is seen at his best. Finally, he brings all the information he has gleaned from this study of ancient methods of painting to bear on the problem of producing the most durable work, and sums up his conclusions on the last page.

The book is completed by a most comprehensive and valuable bibliography of forty-eight pages. The difficulty of preparing such a bibliography is immense, and the author specifically states that it makes no claim to being exhaustive.

For the most part the book is written in a style that combines clearness and accuracy with interest, but there are occasional lapses into looseness and confliction of statement which could be eliminated with advantage in further editions. One feels, too, that rather too much stress is laid on the literary evidence, as compared with that derived from scientific research, and Dr. Laurie sometimes suffers from the spirit of the antiquary in regarding the statements of all old writers as gospel unless they come into direct conflict with practical evidence. For example, a great deal of space is devoted to the discussion of the evidence to be deduced from the writings of Pliny, to which the author attaches a degree of importance which one is inclined to question. The book is, however, a most welcome addition to the literature of the subject, and deserves the serious study of every artist, although perhaps its value can only be fully appreciated by those with a knowledge of technical matters.

GENERAL NOTES.

Royal Photographic Society's Exhibition.—The Society announces its Fifty-sixth Annual Exhibition, to be held in May next at the Gallery of Prince's Skating Club. For some years this Exhibition was held at the New Gallery in Regent-street, but the demolition of this building deprived the Society of its usual quarters. Last year the Exhibition was held in the smaller gallery of the Royal Society of Painters in Water-Colours, Pall Mall. Certain changes are made in the classification of the Exhibition, which ought to add to its interest, and the Society has also partly reverted to the practice of awarding medals. These are now offered in all sections of the Exhibition, except Section I. (Pictorial Photographs).

Festival of Empire: Fine Art Exhibitions.—The British Fine Art Section of the Festival of Empire will consist of the works of specially invited modern artists in three classes:—(*a*) Paintings in oil; (*b*) Water-colours, pastels, and drawings; (*c*) Etchings and lithographs. This section will be exhibited in the West Galleries of the Crystal Palace. The art of the Overseas Dominions will be represented by collections of pictures from Canada, Australia, New Zealand, and South Africa, housed in the different Government buildings erected in the grounds of the Palace. In addition to these exhibitions there will be a special section devoted to pictures representing scenes and incidents of historical interest, together with portraits of men and women who have played their part in the building, defence and administration of the Empire. This section will include a number of important paintings kindly lent by the Duke of Marlborough from the Blenheim Palace collection.

Test for Fire-Damp.—A card and leaflet have been prepared, by direction of the Secretary of State for the Home Department, for the purpose of affording to persons engaged in mining clear and simple instructions on the subject of testing for fire-damp. The method of testing is the one described by Sir Henry Cunynghame, in the paper read before the Society last November, viz., the observation of the appearance of the "caps" corresponding to different percentages of gas. The

leaflet is intended more especially for the use of the under-officials of mines; the card (which is in a form convenient for carrying in the pocket) more especially for miners. Both card and leaflet contain a coloured illustration showing the appearance of the "cap" corresponding to percentages of 1, 1½, and 2, of fire-damp.

THE LABOUR EXCHANGES.—The Labour Exchanges have now been in operation for a year, the first batch of 63 centres having been opened on February 1st, 1910. There are at present 160 exchanges at work, and it is expected that nearly as many more will eventually be established. The total number of vacancies notified to the exchanges during the eleven months ended December 31st, 1910, was over 450,000, and the number filled was 370,000. Somewhat contrary to general expectation, the exchanges have proved more useful in filling vacancies for skilled workmen than those for unskilled labour. As the exchanges are in constant communication with one another, they are able to do a great deal in filling, with men from other districts, vacancies which cannot be filled locally. Between 2,000 and 3,000 vacancies have recently been filled each month in this way. Great assistance has been rendered to this branch of the work by the power of advancing railway fares conferred by regulations made under the Labour Exchanges Act. In several thousand cases fares have been so advanced, and the bulk of the money —usually deducted from the workman's wages by the employer—has been recovered.

THE SEA-OTTER.—The sea-otter, when full-grown, measures from four to four and a half feet in length, but so loose is the skin that it easily stretches to six feet; and so valuable is the fur that a skin of this size is worth at present between £300 and £400. Needless to say, an animal which offers such a prize as this is eagerly sought after; and in his recently-published work, "In Forbidden Seas," Captain H. J. Snow gives some interesting particulars of his experiences as a hunter of sea-otters. These animals frequent the rocky coast of the North Pacific Ocean, making their homes in the great belts of "kelp" which flourish there. In former days they used to be so tame that they would stand with head and fore-paws out of the water, watching the hunter and his gun, but the terrible persecution to which they have been subjected has rendered them exceedingly shy and difficult of approach. In the Kurile Islands, between 1872 and 1881, the numbers killed varied from 300 to 1,500 a year; from 1882 to 1891 about 1,200 were taken; from 1892 to 1901 about 800 were taken; while from 1902 to 1909 only about 350 were killed. The numbers caught in the Aleutian Islands were, however, much higher, over 58,000 sea-otters having been killed between 1873 and 1896.

EXHIBITION OF PRINTS AND ENGRAVINGS AT ROME.—The eighteenth exhibition of prints and engravings was opened in Rome on January 29th last. It occupies four large rooms in the "R. Galleria d'Arte Antica," and includes a very interesting collection of works of the sixteenth and seventeenth centuries, chiefly by the Old Masters. Albert Dürer, Rembrandt, Salvator Rosa, Stefano della Bella, Canaletto, Grimaldi, Jacopo Bassano, Bril, Domenichino, Swanevelt, Guercino, Poussin, Jan Botha, etc., are well represented. Many rare engravings, especially a female portrait by Mengs (recently purchased), are especially worthy of mention.

COMO AT THE TURIN EXHIBITION, 1911.—The silk manufacturers of Como have wisely decided to make a collective exhibit of their products at the Turin Exhibition. No expense is being spared to make the show worthy of the best traditions of the silk industry of Lombardy. A special building is being erected in the grounds, and every effort is being made to render it one of the chief attractions of the exhibition. Eminent artists are engaged in illustrating "The History of Dress" during the fifteenth, sixteenth, seventeenth and eighteenth centuries, which were so especially rich in colour and variety. A collection of antique fabrics should prove especially interesting. It is needless to say that modern manufactures will not be neglected, and the silk stuffs for which the province of Como is so justly celebrated will be well represented, while silk in all the various stages of manufacture and processes of production will be shown with great completeness. The opening of the Turin Exhibition by the King of Italy will take place on the 29th April next.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

FEBRUARY 22.—Professor J. WERTHEIMER, B.Sc., B.A., "Water-Finders."

MARCH 1.—Dr. LEONARD HILL, F.R.S., "Caisson Sickness and Compressed Air."

MARCH 8.—JAMES CANTLIE, M.A., M.B., C.M., D.P.H., "Plague and its Dissemination." Sir SHIRLEY FORSTER MURPHY, M.R.C.S., will preside.

Wednesday afternoon, at 4.30 o'clock:—

MARCH 15.—Colonel CHARLES EDWARD CASSAL, V.D., F.I.C., "The Adulteration of Food." The Right Hon. the Lord Mayor of London will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

MARCH 16.—CLAUDE HAMILTON ARCHER HILL, I.C.S., C.S.I., C.I.E., "Education in India." The Right Hon. Lord NORTHCOTE, G.C.M.G., G.C.I.E., C.B., will preside.

APRIL 27.—Sir THOMAS HENRY HOLLAND, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India." Lord AVEBURY, D.C.L., LL.D., F.R.S., will preside.

MAY 25.—W. R. H. MERK, I.C.S., C.S.I., LL.D., "The N.W.F. Province of India."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

FEBRUARY 28.—The HON. SIR RICHARD SOLOMON, K.C.B., K.C.M.G., K.C.V.O., K.C., M.A., High Commissioner for the Union of South Africa, "The Resources and Problems of the Union of South Africa."

APRIL 4.—Captain R. MUIRHEAD COLLINS, C.M.G., "Australia and her Resources."

MAY 9.—F. WILLIAMS TAYLOR, "Canadian Banking."

CANTOR LECTURES.

Monday Evenings, at 8 o'clock:—

Professor ADRIAN J. BROWN, M.Sc., "Brewing and Modern Science." Four Lectures.

Syllabus.

LECTURE III.—FEBRUARY 20.—"The Mashing Process." The Chemistry of Starch and its Transformation Products—Protein Changes during the Mashing Process.

LECTURE IV.—FEBRUARY 27.—"The Fermentation Process." Previous Treatment of the subject by Dr. G. Salamon in 1888—The Pure Yeast Question in Brewing—Zymase and Modern Views of Alcoholic Fermentation—Nitrogen Assimilation—The so-called "secondary" products of Fermentation, etc.—Conclusion.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 20...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor Adrian J. Brown, "Brewing and Modern Science." (Lecture III.)

Farmers' Club, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mr. J. L. Nickisson, "The Government Horse Breeding Scheme from a Farmer's Point of View."

Bibliographical, 20, Hanover-square, W., 5 p.m. Mr. G. F. Barwick, "The Magazines of the Nineteenth Century."

Surveyors, 12, Great George-street, S.W., 4 p.m. Mr. F. J. Lloyd, "Sugar Beet: Will it Pay to Grow it in Great Britain?"

Victoria Institute, St. Martin's Vestry Hall, St. Martin's-place, W.C., 4.30 p.m. Rev. F. Baylis, "Science in Relation to Christian Missions."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. T. Fyfe, "Germany and the Germans."

TUESDAY, FEBRUARY 21...Statistical, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Messrs. M. Greenwood, Jun., and R. H. Candy, "The Fatality of Fractures of the Lower Extremity and of Lobar Pneumonia. A Study of Hospital Mortality Rates, 1751-1901."

Sociological, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8.15 p.m. Dr. C. W. Saleeby, "The Foundations of Eugenics."

Royal Institution, Albemarle-street, W., 3 p.m. Professor F. W. Mott, "Heredity." (Lecture VI.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. W. T. Douglass's paper, "Coast-Erosion."

Photographic, 35, Russell-square, W.C., 8 p.m. Exhibition of Prints by Members of Affiliated Societies, with Notes by Mr. W. J. Morgan.

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Dr. H. G. Plimmer, "Report on the Deaths which occurred in the Zoological Gardens during 1910." 2. Mr. R. Lydekker, "On *Tragelaphus Buxtoni*, an Antelope from Abyssinia." 3. Mr. E. G. Boulenger, "A Contribution to the Study of the Variations of the Common Salamander (*Salamandra maculosa*)." 4. Mr. G. A. Boulenger, "On a Collection of Fishes from the Lake Ngami Basin, Bechuanaland." 5. Dr. F. D. Welch, "Observations on different Gibbons of the Genus *Hylobates* now or recently Living in the Society's Gardens, and on a *Symphalangus syndactylus*, with Notes on Skins in the Natural History Museum."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mr. G. H. Scholefield, "The Origins of the New Zealand Nation."

WEDNESDAY, FEBRUARY 22...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Professor J. Wertheimer, "Water-Finders."

Geological, Burlington House, W., 8 p.m. 1. Mr. R. H. Rastall, "The Geology of the Districts of Worcester, Robertson, and Ashton (Cape Colony)." 2. Baron Ferencz Nopsca, Jun., "The Geology of Northern Albania."

Auctioneers, 34, Russell-square, W.C., 7.30 p.m. (Junior Meeting.) Mr. E. L. Pierce, "Land Banks and Agricultural Co-operation."

United Service Institution, Whitehall, S.W., 3 p.m. Mr. W. F. Reid, "The Use of Explosives in Aerial Warfare, with some remarks on Methods of Defence."

Literature, Royal Society of, 20, Hanover-square, W., 5 p.m. Dr. W. E. A. Axon, "Sources of Longfellow's 'Tales of a Wayside Inn.'"

Mining and Metallurgy, at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W., 8 p.m. 1. Mr. A. Beeby Thompson, "The Relationship of Structure and Petrology to the Occurrence of Petroleum." 2. Mr. A. L. Shrager, "Shaft Sinking against Water in Fissured Ground by Cement Injection."

THURSDAY, FEBRUARY 23...Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Child Study, 90, Buckingham Palace-road, S.W., 7.30 p.m. Discussion. "Should Games be Organized?"

Royal Institution, Albemarle-street, W., 3 p.m. Dr. P. Chalmers Mitchell, "Problems of Animals in Captivity." (Lecture III.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. F. H. Evans, "Pianism of the Pianola."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Discussion on Mr. W. T. Taylor's paper, "Long Distance Transmission of Electrical Energy," and Messrs. R. B. Matthews and C. T. Wilkinson's paper, "Extra High Pressure Transmission Lines."

FRIDAY, FEBRUARY 24...Royal Institution, Albemarle-street, W., 9 p.m. Professor Jean Perrin, "Mouvement Brownien et Realité Moléculaire."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. J. Swinburne, "The Uses of Chemistry in Engineering." (Lecture II.)

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7.30 p.m.

SATURDAY, FEBRUARY 25...Royal Institution, Albemarle-street, W., 3 p.m. Mr. T. G. Jackson, "Architecture: The Byzantine and Romanesque Period." (Lecture III.)

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FRIDAY, FEBRUARY 24, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 27th, 8 p.m. (Cantor Lecture.) Professor ADRIAN J. BROWN, M.Sc., "Brewing and Modern Science." (Lecture IV.)

TUESDAY, FEBRUARY 28th, 4.30 p.m. (Colonial Section.) The Hon. Sir RICHARD SOLOMON, K.C.B., K.C.M.G., K.C.V.O., K.C., High Commissioner for the Union of South Africa, "The Resources and Problems of the Union of South Africa." The Right Hon. LEWIS HARCOURT, M.P., Secretary of State for the Colonies, will preside.

WEDNESDAY, MARCH 1st, 8 p.m. (Ordinary Meeting.) LEONARD ERSKINE HILL, M.B., F.R.S., "Caisson Sickness and Compressed Air."

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURES ON "BREWING."

On Monday Evening, the 20th inst., Professor ADRIAN J. BROWN, M.Sc., delivered the third lecture of his course on "Brewing and Modern Science."

The lectures will be published in the *Journal* during the summer recess.

CANTOR LECTURES ON "PYROMETRY."

The Cantor Lectures on "Pyrometry," by Mr. Charles R. Darling, A.R.C.Sc.I., F.I.C., have been reprinted from the *Journal*, and the pamphlets (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John-street, Adelphi, London, W.C.

A full list of the Cantor Lectures which have been published separately, and are still on sale, can also be obtained on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A Meeting of the Indian Section was held on Thursday, February 9th, 1911, the Right Hon. Lord LAMINGTON, G.C.M.G., G.C.I.E., presiding.

The paper read was—

INDIAN SUPERSTITIONS.

By R. A. LESLIE MOORE, I.C.S. (retired).

PREFACE.

I should like to preface my paper on Indian Superstitions with two remarks. The first is that the paper does not pretend to be exhaustive, and the second that it is not written in any spirit of condescending superiority towards the domestic beliefs of a people whose civilisation is older than our own.

Such an attitude would ill become a citizen of the United Kingdom, where in England persons not devoid of education are averse from sitting down thirteen to dinner, where in Scotland the careful housewife hopes that the first foot set in her house on New Year's Day will be that of a dark man, so that the household may have good luck throughout the year, and where in Ireland no good old family can do without its banshee, that uncanny harbinger of woe which, *more Hibernico*, laments a death before it has occurred. I should like also to acknowledge my obligations to various friends, both Indian and Anglo-Indian, and last, but not least, to the Bombay Anthropological Society for information supplied.

OMENS.

To turn to the subject of the paper, let us begin with the Indian belief in omens. Among Hindus it is a good omen to catch sight of the following things:—(1) curds, (2) *ghi*, (3) rice, (4) milk, (5) flesh, (6) fruit—all it will be noticed, common articles of diet; (7) a looking-glass, (8) ornaments, (9) jewels, (10) newly-washed

clothes, (11) an umbrella—all of which may be termed articles of the toilette, except perhaps the umbrella; (12) a cow, (13) an elephant, (14) a dog wagging its tail—all three familiar quadrupeds to the Hindu, and not hard to see, especially the elephant; and finally some sundries, such as (15) precious metals, (16) weapons, (17) a sparrow, (18) a peacock, (19) a soldier, (20) a blot of ink.

The Hindu has then a fairly good chance of getting good omens, and if the same rules apply to Londoners we may all hope by good luck to catch sight of sparrows and tail-wagging dogs. On the other hand, it is an evil omen for a Hindu to see:—(1) a smoky fire, (2) medicine, (3) salt, (4) oil, (5) hay, (6) timber, (7) rain, (8) mud, (9) cats, (10) owls, (11) snakes, (12) a beggar, (13) a drunkard, (14) a bald man, (15) a grey-eyed man. Obviously a Hindu must be careful where he looks. But it seems hard on the grey-eyed and the bald to class them with drunkards. And as for Londoners they stand, I am afraid, a poor chance, what with rain, mud, beggars and cats.

But the worst omens of all are to stumble when starting on a journey and to drop a plate. It is pleasant, however, to know that a stray pigeon brings good luck to the house where it alights, that a cat cleaning its face with its paws predicts the arrival of relations, and that, contrary to the usual rule, good luck is brought to a house by a black cat with a white face. On the other hand, Hindus believe the omen bad if at the commencement of a journey the right eye of a woman or the left eye of a man throbs or winks.

Among Indian Mussulmans an unlucky omen at the commencement of a journey is to hear a donkey braying or a jackal yelling—neither of them uncommon sounds in India. But the cry of the black partridge, though scarcely melodious, is lucky, and it is lucky, too, to set out with the moon full in one's face. Good fortune may also be secured at the start by presenting someone with a pie; as three pies go to a farthing, the price of good luck does not seem excessive.

Among Parsis good omens are drawn by travellers setting out on a journey from the sight of:—

1. A woman with a full water-pot on her head.
2. A sweeper with a basket on his head.
3. A washerman carrying a bundle of clean clothes.
4. Flowers or fruit.
5. A snake on the right hand.
6. A pot of toddy.
7. And finally a corpse. The belief in the last good omen is shared by Hindus. It is also lucky for the traveller just after starting to look back when called, as that means he will return safe and sound. But bad omens are drawn if the traveller, on setting out, catches sight of:—

1. A woman with an empty water-pot.
2. A washerman with a bundle of dirty clothes.
3. A snake on the left hand.
4. A cat crossing the path.

It is lucky to hear a clock striking, a bell ringing, or a gun firing during the discussion of a business enterprise, as the omen drawn is that the enterprise will succeed; but it is most unlucky to hear on such an occasion a woman sneeze—apparently the moral is that women and business are best apart. I regret to conclude with a trio of bad omens, which consist in the breakage of a chandelier or globe, the breakage of a wife's glass bangles, and hearing at night the howling of a dog. As regards the bangles, the ill-luck is about to occur to the woman's husband; this belief is doubtless due to the fact that a woman on becoming a widow breaks or takes off her bangles.

Among Goanese Christians, it is a good omen to see:—

1. The mother of a large family.
2. A cow with a calf.
3. A marriage procession.
4. A sweeper.
5. A widow (if she is young and comely).

But it is a bad omen to see:—

1. An ordinary widow.
2. A faggot of wood.
3. A piece of coal.
4. A bare-headed man out of doors.

The Goanese also believe that a sick man is near to death if a dog howls, an owl hoots, or a crow caws in his vicinity. They think these creatures can scent the approach of death—a faculty shared by the Irish banshee. Probably in all three cases the bad omen is due to the melancholy nature of the sound.

The Hindus in Portuguese territory believe that if a cat mews at night she predicts the approaching death of a member of the family. It is thought that an ancestor has taken the shape of a cat to give his relatives warning. However, the omen may be averted by offering food to the spirit of the deceased, similar viands being consumed by the males of the family. The

ladies, however, must not partake, as they are ceremonially impure.

The Evil Eye.

Let us now consider the fascinating subject of the "evil eye." Belief in the evil eye is not, of course, confined to India. It is prevalent, for instance, in Italy. Many of us will remember Rudyard Kipling's gruesome story of the haunted bungalow, where the mangled corpse of the young assistant magistrate was found between the ceiling and the roof. The unfortunate youth's throat had been cut by his servant because the man believed the Sahib had cast the evil eye on his little son. According to Indian belief, good and comely persons and things are those most in danger of suffering from the evil eye—the basic idea perhaps being that good fortune breeds the pride that goes before a fall. The evil-eyed one is not necessarily a person of evil nature, and, most unfortunately, does not exhibit any outward and visible sign —such as a squint—by which he may be recognised and avoided. However, for the protection of the public, it is well to place on record that there are certain classes generally addicted to this deplorable characteristic, *e.g.*, witches, beggars, scavengers and Europeans—not a flattering collocation to the latter, but it is well sometimes "to see ourselves as ithers see us."

An attack of evil eye may be diagnosed by the symptoms of loss of appetite, vomiting, fever and sometimes delirium. As prevention is better than cure, the first essential is to ascertain how the evil eye may be averted. Well, a prime specific, especially in the case of children, is to rub some lamp-black on the forehead. More ornamental prophylactics are bears' hair, tigers' claws, and shell garlands. For the protection of trees a tasteful appendage of old shoes is highly effective, and animals are safeguarded by black threads fastened round their necks or horns. We have next to consider how the effects of the evil eye may be cured. A favourite remedy is to mix on a tile some dust from a spot where three cross-roads meet, with salt, chillies, and coriander seed, then to wave the tile round the head of the patient, and finally to put it in the fire. Hindus have also great faith in a thread tied round the arm of the patient over which a Brahman priest has repeated mantras, while Goanese Christians prefer to burn in the patient's presence a hair or thread obtained from the evil-eyed one without his knowledge or consent, somewhat on the principle of curing a bite by a hair of the dog that bit.

Spirits.

From the evil eye let us pass on to the topic of spirits, both disembodied spirits commonly called ghosts, and spirits who have never had a human body. The latter are in India divided, like their human contemporaries, into two chief classes — Mohammedans called Djinns, and Hindus called Bhuts. I am credibly informed that Djinns can easily be recognised by their inability to wink—whether owing to physical or moral rigidity I am unable to say. However, as a compensation they are provided with elastic arms and legs. Thus, a Djinn would think nothing of suddenly stretching out his arm and picking a sparrow off a housetop or extending his leg and crushing with his foot a black-beetle at ten or twenty paces distance. To turn to Bhuts, in my green and salad days in Poona I remember that the first chuprassie I ever had absented himself for a week at the time of Holi, a season of merrymaking, on the plea that he was suffering from shock—the shock of meeting a Bhut near a burning-ground on his way home. He recognised the Bhut by his eccentric method of walking with his heels in front and his toes behind. In fact his feet were reversed on his ankles. By this you may know the Bhut. Riding on another occasion into a Sindhi village, I found the village accountant's official residence, which stood on the outskirts of the village under a spreading banyan tree, deserted, and the man himself located in a hut in the main street. On inquiry I was informed that the banyan was haunted by a Bhut who objected to neighbours, and showed his objection by throwing stones at them.

My third experience of Bhuts occurred in Khandesh. Visiting an outlying village early one morning I was met by a deputation, who asked me to order the arrest of a Bhut. Thinking that even a Bhut should have fair play, I asked for details of the charge, and was told that the accused had the night before levanted with a baby. It appeared that the keeper of the local liquor shop had gone the previous day to a larger village to replenish his stock, leaving at home his mother, his young wife and infant. According to the wife, at dead of night a black, hairy Bhut came down the chimney, tore the baby from her arms, and again disappeared up the chimney. Full inquiry was made, but the infant was never recovered, nor was any reason for its removal disclosed. I am inclined to think that the Bhut was really a wolf which entered and departed through the door, and that the women were

afraid to confess this lest they should be blamed for failing to bar the entrance.

It is perhaps well to know that Bhuts may be exorcised by an offering of curds, for which they have a liking, more especially as low-class Bhuts are in the habit of causing nightmares by sitting on the victim's chest and trying to suffocate him. This class of Bhut is probably the offspring of indigestion.

To proceed from Bhuts in general to Bhuts in particular—*i.e.*, local species of the genus Bhut—it may be noted that in Bengal there is an unpleasant specimen called Nishi, who is accustomed to take her walks abroad in female human form after midnight. She calls people thrice by name, and if they come out of doors lures them into the jungle and destroys them. Hence, in Bengal, if you wish to get a friend out of doors after midnight, you must call four times.

One of the residents of the Madras Presidency is a superior sort of lady Bhut called Amman. Her *spécialité* is the infliction of small-pox and cholera, but she can be placated by the sacrifice of goats and cocks, and the performance of frantic dances by anyone who likes the exercise. She has no special priests, and her temples are always on the village outskirts. It may be noted that when the dancer becomes hysterical through his exertions he is questioned by the bystanders as to the cure of disease, the method of accomplishing wishes, the welfare of absent friends, and other interesting topics.

In connection with these Madrasi Bhuts, I remember reading that a certain touring member of Parliament once instanced in the House of Commons the fact that a deceased officer's manes were placated with offerings by the local Dravidians as a proof of the tyranny of British rule in Madras. As a matter of fact, the poor man had died in a lonely spot near the coast on his way to England, and the kindly villagers, rightly thinking that his ghost would feel lonely so far from home, were in the habit of offering it consolation in the appropriate form of spirits and cigars, a proceeding that did much credit to their good nature.

I may conclude my remarks on Bhuts by mentioning a Goanese species called Vento Ruim, who hovers over men, counteracting the influence of their good angels and impelling them to evil. Vento Ruim seems to be the local form of a Christian idea that each human being has an attendant guardian angel and malign spirit, the embodied forms of good and evil tendencies.

We will next deal with disembodied spirits, commonly called ghosts. An eminent medical officer told me of a haunted bungalow inDharwar, said to be the local habitation of a deceased ayah. This obtrusive female had the habit of appearing to ladies shortly after childbirth, who never survived the shock of her appearance. He told me of two such deaths in this bungalow, for which he was unable medically to account.

Then I was told by an acquaintance that he had himself seen in a Sindh district bungalow the ghost of a servant who was said to have committed suicide there. The spectre was in the habit of appearing to visitors, and pointing to its throat, which was cut from ear to ear. My acquaintance, however, was notoriously subject to fits of nightmare and imagination.

In a third case an assistant collector, whom I knew, managed, with the aid of a thick stick, to exorcise an uneasy sprite which had a taste for mangoes, especially those growing in my friend's compound. In this case the reputed ghost was found to occupy for the time being the earthly tabernacle of a neighbouring fakir.

But to turn from the particular to the general. There is a belief that the spirit of a deceased person will sometimes pay off old scores by haunting an enemy. This reprehensible practice is most common amongst deceased daughters-in-law, and, in order to prevent its occurrence, mothers-in-law who are conscious of having been overstrict will sow mustard-seed between the family mansion and the burning ghaut. The ghost, on its return journey, lingers to pluck the mustard flowers, and so is overtaken by the dawn, when it has to return whence it came.

Another belief among Hindus is that for ten days after death the spirit of the deceased lingers in the house. An oil lamp is, therefore, kept burning, round which the ghost hovers like a moth, transmigrating, at the end of the ten days, into another body.

In Goa it sometimes happens that stones are thrown by unseen hands on the roofs of houses occupied by native Christians. This affront must not be credited to mischievous Bhuts or boys. No! The stone-throwers are the souls of the departed faithful, who find that their exit from purgatory has been delayed by an insufficient expenditure on masses and alms on the part of their surviving friends. When the deficiency is made good, the stone-throwing ceases.

To conclude with a warning. Do not go after dark near a well or pond in which anyone has been drowned, as the ghost of the deceased haunts the place and may injure you—at least, so Hindus believe. They think that women are

sometimes obsessed by such spirits. However, it is well to know that shouting "Ràm, Ràm!" will drive away ghosts, and this precaution should be observed, especially on Tuesdays and Saturdays, when spectres have their evenings out. Perhaps I may add one remark—not about ghosts exactly but about what Madame Blavatsky and her friends called "astral projections." Sometimes, when a man is asleep, his astral projection goes out for an airing and occasionally gets thirsty. Then it repairs to an uncovered water-jar, and if the cover is put on suddenly the A.P. is shut in, to the inconvenience of its sleeping owner.

Marriage.

Perhaps something cheerful would be desirable after so gloomy a subject as ghosts. Let us, then, briefly consider ideas about marriage. Bachelors and spinsters should please take note.

Anyone killing a frog will never get married. On the other hand, according to a picturesque Bengali fancy, if a butterfly enters and flits about a house there will soon be a marriage in the family; and if the butterfly persists in hovering about any particular person, that person is destined for early connubial bliss. The following Hindu receipt for securing husbands will be of interest:—Let the aspiring spinster buy curds at a shop that is about to close for the day, or let her look upon a bridegroom at a marriage ceremony, and then, turning her back upon him, go straight home. The result will be all that can be desired.

Perhaps one or two items from the marriage customs of other Indian people will be acceptable. A Parsi bride, when being adorned for the marriage ceremony, always stands with her face to the East, as the East is the lucky quarter because the sun rises there. Among the Mussulmans of Sindh the bride is seated on an overturned basket under which a hen and a brood of chickens have been placed. Then she rises and lifts up the basket, letting the chickens out. The number of chickens she can catch is the number of her future progeny. After this display of agility, she has to engage in a feat of strength by holding a date grasped in her fist. If the bridegroom with one hand can deprive her of the date he will rule in the married life to come, but if he fails he may expect, as the Scotch say, to be "Sair hadden doon." When the bride goes to the bridegroom's house for the first time her mother-in-law takes care to secure good luck for the marriage by having the posts of the house-door smeared with the blood of a goat slain for the purpose, and by swinging a black hen thrice round the bride's head just before she enters the house.

Magic.

We must now be sufficiently braced up to tamper with the awesome subject of magic—*i.e.*, witches and wizards, charms, spells and prophecies. I have a very clear recollection of one victim of witchcraft, whose acquaintance I made when inspecting the jail in the Guzerat State of Dharampur. The Raja, who was opposed to capital punishment, had sentenced him to imprisonment for life because he had killed his mother-in-law. The prisoner—he was a Bhil—explained to me that he had quarrelled with his mother-in-law, who was a witch, and she in revenge had bewitched his little boy, his only son, so that the child fell sick and died. The father's repartee took the form of cracking the old woman's skull with a wood-chopper.

Indian wizards bring disease, and even death, on their enemies by making effigies of them, which they maltreat much as did the European sorcerers of the Middle Ages. The Hindu wizard shoots arrows into his effigy from a bow made of a bamboo, which has been used to fasten down a corpse during its cremation.

The Mohammedan practitioner, on the other hand, makes his effigy out of grave mould and transfixes it with pegs to the accompaniment of passages from the Koran recited backwards. The effigy is then buried in a graveyard in the sure and certain hope of the speedy death of the original. Apparently, in these cases the effigy represents the "other self" of the victim, the idea of a double self being common to many races.

The above may be called black magic. However, white or beneficial magic is also well known in India. Hindus frequently call in sorcerers to deal with cases of hysteria, which they ascribe to demoniacal possession. The sorcerer's *modus operandi* is briefly as follows. He begins by demanding presents for himself and the demon. Then he recites incantations, at the same time passing his hands over the patient and rubbing him with a mixture of oil and dust or water and dust. If this does not suffice he belabours the patient with a slipper or a broom, frequently with satisfactory results. It is claimed that other diseases besides hysteria can be cured by incantations and external applications, but another method is to transfer the diseases from the patient to someone else. This the sorcerer accomplishes by drawing cross-lines on a road, at the same time repeating incantations. The first person who walks over the lines relieves

the patient by taking his diseases upon himself. Such a belief must add a new horror to life. Another less callous method of transferring an ailment—in this case consumption—prescribes that the patient should swallow a piece of paper inscribed with a magic formula, written in Sanskrit for Hindus and extracted from the Koran for Mohammedans, and should then undress and bathe in the midst of a crop of sugar cane. The consumption will leave the patient and attack the crop in the form of blight.

Goanese Christians believe that their local sorcerers can foretell the future when frenzied by dancing wildly like the Madras devil-dancers. Sorcerers are also very useful in detecting witches. This they do either by throwing salt on the suspect, which benumbs her if she is guilty, or by requesting her to step over a ladder, which she cannot do if really a witch.

These methods are much more humane than those in vogue in England in the days of King James the First, when it was customary to throw the suspect into a deep pond. If she sank to the bottom and stopped there she was innocent—much to the consolation of her surviving friends; but if she floated she was a witch, and was promptly taken out to be hanged or burnt.

Something may now be said about charms and spells. Parsi cultivators protect their crops from vermin by placing in their fields charms written down by a priest after prayer and ablution. Hindu cultivators achieve the same end by putting amid their crops a magic square, of which the numbers total up to thirty-two whether added perpendicularly or horizontally. I understand that in Burma, Was protect their crops by placing among them human heads cut off for the purpose, the idea being that the spirits of the deceased will warn off other sprites. With this may be compared the Indian idea that the spirit of his first victim sits on the head of a man-eating tiger and directs him where to go.

Goanese Christians have a choice collection of charms for removing the evils caused by witchcraft. The chief of these are:—

1. Earth from saints' graves.
2. Relics of saints.
3. Written prayers addressed to saints.
4. Images of saints.

They also have a picturesque belief that oars, sails and bells sprinkled with holy water are safeguarded against thunderbolts.

Some details of the Mohammedan belief in the miraculous powers of Syuds, dead and alive, may not be out of place. The spirit of a dead Syud is supposed at times to obsess living persons, and make the announcement in the Syud's name that offerings should be made at his grave. I remember myself an instance that occurred over twenty years ago at Ahmedabad, when a deceased Syud resented the decrease in the offerings at his shrine by growing in his grave (so the caretaker of the shrine informed the public). This underground growth necessitated the lengthening of his tomb above ground, and such was the elongation of the holy man that a public path was in danger of being blocked. At last the district magistrate had to address an injunction to the caretaker of the tomb, after which the deceased grew no more.

On another occasion, when I was arranging a campaign against locusts in the Rohri district of Sindh, which borders on the Jaisulmir desert, an ancient zemindar told me we ought to have the aid of the Syud Hazrat Shah. I expressed myself pleased at the prospect of the Syud's co-operation, but was informed that the worthy divine had sought the arms of the Houris long years before. However, it appeared that his practice had been to catch one of a swarm of locusts and ride off with it into the desert, whither the swarm followed him not to return. I may, in conclusion, mention a story current in the town of Rohri that some fifty years ago a certain holy Syud had raised from the dead the Bunnia who used to lend him money because the trader had left no son behind him to transact the Syud's business. The Bunnia, who had been recalled to life while being carried to the burning-ground returned home and obligingly begat a son. As soon as the latter had reached years of discretion, the father was allowed to shuffle off the mortal coil in peace. This tale was told me as strictly true by an educated Hindu of the Amil caste, who said his father had known all the parties in the case.

The shrines of deceased Syuds are favourite places for pilgrimage and votive offerings. Near Rohri is the shrine of the famous Saki Sarvar (Nur Jo Parwar, protector of light, as he is popularly called). His *spécialité* is the cure of sore eyes. Hard by Ahmedabad is the shrine of the equally renowned Shah Alum. Often have I seen the railings round his tomb adorned with little locks of infants' hair, presented by happy mothers to whom the deceased saint had vouchsafed a son in answer to their prayers.

In this respect India and the Emerald Isle are close akin. In the year 1909 I saw in

County Louth a holy well overhung by a tree, the branches of which had been festooned with rags by pilgrims. To the best of my recollection St. Bridget was the patron saint of the locality.

Now, it is easy to smile at such simple practices, but faith works wonders, as an instance of which let me quote an experience of my own. I had on one occasion to deal with a severe outbreak of cholera in East Khandesh. One village remained unscathed in a circle of others that were affected. On visiting this village I found it surrounded by a line of cotton yarn tied from tree to tree, and the Patel informed me that the villagers had taken the precaution at the outbreak of cholera in the neighbourhood of publicly expelling a Mang woman from the village bounds with beat of drum, after which they encircled the village with cotton yarn. In consequence cholera did not enter their precincts.

Perhaps before leaving the subject of magic I may mention the Mohammedan custom of foretelling the future by consulting the King of the Djinns—called Hazirat. This is done by the operator hypnotising a young boy, after placing in his hand a betel-leaf smeared with lamp-black. The medium, looking on the lamp-black, answers the operator's questions by telling him that he sees the King of the Djinns appear as in a mirror. The King, on being questioned, answers the questions put to him through the medium.

Hindus foretell the future both by astrology and palmistry. I remember that a Hindu astrologer foretold a devastating earthquake in the spring of 1898, when I was at Surat. I happened to go out after black buck very early on the morning when the earthquake was due, and found the population of whole villages sleeping with their cattle in the fields—old men and children, young men and maidens. They told me they thought their chances of escape from the earthquake were somewhat better in the open. Well they did escape, for the earthquake never came off. On my chaffing a Hindu friend about this, he replied indignantly that the astrologer had been quite right—only the earthquake had happened in Persia. I have heard of a Madras astrologer who acquired a competence by predicting the issue of cases tried by the local High Court. An instance in which a palmist successfully foretold the future occurred to my knowledge in the case of a lady who had lately settled down in a house near Bombay, shortly after arriving from England. A Hindu palmist informed her that she would presently give up the house and revisit Europe. She laughed at his apparent bad shot, as she had only just returned from home, and her husband had taken their house on a three years' agreement. Yet in a month or two news of the illness of a relative recalled her to England, and shortly after her arrival in London she received a letter from her husband, telling her that there was a flaw in the agreement, of which the landlord had taken advantage to cancel his tenancy.

Animals, Birds, Reptiles, Insects, and Trees.

We may now pass from supernatural things to things natural, so far at least as they can be considered natural when viewed with the eye of superstition. I propose to treat of beasts, birds, reptiles, insects and trees.

Anyone who has ever shot a tiger will remember the precautions necessary to prevent the beaters from clipping the deceased's whiskers. The jungle tribes believe that a diet of clipped tigers' whiskers will endow them with the courage and vigour of the jungle king, though, *prima facie*, the probable result would be indigestion. The terror inspired by a man-eating tiger is naturally increased by the belief that the ghost of his first victim sits on his head and directs him where to go and what to avoid. Can any good come out of a panther? Certainly. Panther's fat is good for rheumatism, and the milk of a she-panther is a sovereign remedy for sore eyes. My authority for the former statement is the excellent Raja of Dharampur, whose jail I have already mentioned. I supplied him with panther's fat at his own request, as advancing years were affecting his honourable bones with the aches that human flesh is heir to. I have myself seen beaters squeezing the milk from the dugs of a she-panther just shot by me, and catching it on leaves in order, as they informed me, to keep it as an eye lotion. A bear is notoriously an awkward customer to meet face to face on a jungle path. However, a shout will generally make him retreat. But shout before he growls because, in growling, he straightway becomes deaf. Hence the Mahratta proverb, "Aswalitsya adhi kink phodavi"—shout before the bear growls. This saying is applied to quarrels, and suggests that the man who speaks first is generally believed—in other words, it is hard to overtake a lie.

Indians will often choose a horse, not for the feminine reason that he has a nice tail, but because of certain lucky curls in his hair. In Madras, Hindus have a poetic fancy that the

callosities on a horse's legs show the places where wings once grew.

In olden days men warred against the gods, and tried to fly to heaven on winged steeds. The gods then took the precaution of clipping the horses' wings. Can it be that this myth is a reminiscence of prehistoric aeroplanes? Do not walk over the place where a donkey has lately rolled if you wish to avoid pains in your feet. Donkeys are not favourites in India. Their nostrils are slit in a vain attempt to soften the harshness of their bray. Naturally enough the donkey is supposed to bray because he catches sight of the devil. He is looked upon as unlucky because he is the steed of Sitala, goddess of small-pox. This lady's favourite offering is a pig, which should be let loose in her honour by those who recover from small-pox, lest they suffer again.

Hindu shrines are often built where milch-goats have let down their milk, which they are reported to do when they have discovered a holy place. Orthodox Hindus may (and do) hit cows with sticks, but consider it improper to kick them. When they break bread they keep the first piece for a cow, the second for a dog, and the third for a crow. During epidemics an attempt is often made to free a village of the disease by garlanding a buffalo, putting a red caste-mark on his forehead, and driving him out of the village. Hindus believe that the stripes on the Indian squirrel are the marks of the Monkey King Hanuman's thumb when he seized it to fill up the last gap in the bridge he built between India and Ceylon. This brings us naturally to the joyous monkey. This fascinating creature is the centre of various Hindu beliefs. Thus, he does not speak for fear he should be made to work. He is often kept in a stable to avert ill-luck from the horses, because, like the quail, he is an ill-luck conductor. You are in luck if you see him before breakfast, but you must not speak of him.

Finally, it may interest the audience to know, that in Hindu opinion the English are descended from Hanuman, the Monkey King. After all, Hanuman was a good fighter, and apparently a cheery soul, to judge from the red-leaded images of him adorning every Deccan village.

Indian Mohammedans have their own beliefs about animals. For instance, they recognise the thumb-mark of their great Prophet on the neck of every well-bred Arab horse. They give an historical reason for the camel's hump by saying that it represents the mountain into which the Angel Gabriel conveyed the body of Moses laid on the camel's back—humpless before that day.

Mohammedans have a poor opinion of dogs. A vessel from which a dog has drunk must be washed seven times to cleanse it. Angels will not enter a house where there is a dog. (Here it may be noted that Hindus believe that dogs can see spirits.) Mohammedans, again, have a quaint cure for hydrophobia. This consists in looking down seven wells. Finally, they assign places in Paradise to certain mammals, of which the following are the chief:—

1. Moses' camel.
2. Abraham's ram.
3. Solomon's ant (praised for industry).
4. The Queen of Sheba's parrot (renowned for eloquence).
5. Jonah's whale.
6. And last, but not least, the golden calf worshipped by the erring children of Israel.

To turn again to Hindu beliefs. The owl in the East as in the West is a foreboder of evil to come. But mark this: It is worse than useless to throw stones at it. For it picks up the stone and gradually rubs it down to powder. As the stone wears away so the thrower falls into a decline, and finally becomes dust to dust at the same time as his missile. The Indian crow is, of course, a ruffian of the deepest dye, and yet he has his uses. Pious Hindus annually offer rice balls to the spirits of their departed ancestors and these must be consumed by the crows to show that the offering has been accepted. It is this belief that put a stop to a crusade for the extermination of crows in Bombay City not many years ago.

A parrot is a lucky bird to have in a house, perhaps because he is the steed of Kama, the Indian Cupid. Indian mothers will divide almonds between parrots and their small children in order that the latter may acquire the parrot's fluency of speech. A quail is also a lucky pet, but for a different reason; he attracts misfortune to himself—is, in fact, a sort of bad-luck conductor. If a koil, or brain-fever bird, persists in emitting his excruciating song near your house you may expect the arrival of a relative. But if a pigeon builds in your roof ill luck will come and your house will become deserted. However, if on a business journey you meet a kite with a white bill you may hope for success. If a spider falls on you, you will soon get new clothes, but the touch of a lizard pollutes you. In Burma, however, the image of a lizard is considered a talisman against danger. Should you kill a snake burn his corpse, because he is

by caste a Brahmin. Snakes are considered the guardians of the village cattle. The cobra carries a precious jewel in his head which is an antidote to poison, and brings good luck, but it is hard to secure. The bis-cobra is supposed to be endowed with legs and a sting in its tail.

I remember once being roused by a hurly-burly in my verandah at Jacobabad, and on going out to inquire was shown with pride a bis-cobra which my chuprassies had jointly succeeded in belabouring to death. They told me if it stung anyone the victim must run to the nearest water for which also the bis-cobra would make. Whoever lost the race would die. The reputed bis-cobra, however, turned out to be a thick-tailed stingless lizard. The graceful pipal tree (*Ficus religiosa*), whose slender pointed leaves quiver in every passing breath of air, attracts to itself varying superstitions. Thus Buddhists believe that its nerves were upset by the tremendous scenes it witnessed when Gautama Buddha sat in its shade and endured temptation at Buddh-Gaya when the world was young. Hindus, on the other hand, imagine that the rustling of its leaves is caused by the whispering of spirits who sit aloft among its branches, the spirits of little Brahmin boys who died before they donned the sacred thread. Hence one should never tell secrets under a pipal tree for the spirits will overhear and repeat them. The banyan (*Ficus indica*) and the neem (*Melia azadirachta*) are favourite haunts of Bhuts, and should be avoided by ladies.

Miscellaneous Superstitions.

Perhaps I may be allowed a few remarks about miscellaneous superstitions. It is a common belief that the foundations of large masonry works cannot be well and truly laid without a human sacrifice, preferably the insertion of a human head, amid the building materials. There was a belief during the early days of the plague in Western India, also turning on human sacrifice, of which I had personal experience. It was thought that an ointment of human brains was required by Government to remove the stains from Queen Victoria's statue in Bombay, which some ruffians had defiled at night. Hence much of the reluctance to go to the plague hospitals, where the Doctor Sahib lay in wait to poison patients and extract their brains. Hence, too, the falling off in the attendance at schools in the backwoods of Surat, as I found on tour.

In days of yore Goanese fishermen used to propitiate the sea at the beginning of the fishing season by offering up human victims, but in these less hardy times they rest content with cocks. On the day of Nareh Pornima, Hindus throw coco-nuts into the sea as an offering to the marine deities, and Brahmins bind amulets round fishermen's arms to protect them against the perils of the deep. Two more Goanese beliefs may be mentioned. One is that if a crime has been committed and a number of persons are under suspicion, they should in turn place their hands on an iron pot in which a cock has been placed. The cock will crow when the guilty man puts his hand on the pot. Another is that the corpse of a murdered man will bleed if the murderer draws nigh. The same belief prevailed in Scotland, as narrated by Sir Walter Scott in "The Fair Maid of Perth."

To turn to less gruesome beliefs, Hindus think that to have a lucky day one should begin by looking on a lucky face, so they look at themselves in a mirror. They have a specific against seeing ghosts, which consists in sleeping with an almanac under one's pillow. Then they have their own ideas about hygiene just as some of us have. Thus they think that drinking water immediately after eating bananas causes goitre. And eating ducks' eggs causes rheumatism. Moreover, it is unlucky to eat any sort of egg when starting on a journey. Housewives will be glad to know that cockroaches improve the sanitation of a house. If a Hindu husband dreams of a snake he is about to become a father. When the baby arrives in due course, the day after its birth pen and ink are kept near it so that Chitragupta, the God of Fortune, who will shortly pay a call, may have facilities for writing its fate on the child's forehead. Hindus have what may be called compensatory beliefs about drowning. Thus they think that anyone whose hair curls in a certain way is born to be drowned, but, on the other hand, that anyone who accidentally eats ants in sugar will escape drowning. So there is hope even for the curly-headed. But neither they nor any other man should venture into a boat with a single woman. However, it is fair to add that the femme-sole is equally dangerous to one man or many. A Hindu thinks that three is an unlucky number, so never gives three presents to a friend. He also believes that if he bites his tongue when eating he is being abused by someone. With this compare the European idea about ear tingling. Shakespeare remarks that, "Debt doth often lose itself and friend." Well, the incautious lender has some warning among Hindus, for he can tell by the

number of moles on the debtor the number of debts the latter contracted in a previous state of existence. Hindus think it kindly to snap their fingers if anyone yawns in their presence, to prevent stray devils skipping down the yawner's throat, just as they draw patterns before their doors at Divali to keep demons rom entering their houses. Again, they deem unlucky for a man to shave on his birthday. Similarly, an Irishman who shaves on Sunday runs the risk of toothache. Parsis, too, have their prejudices for they are averse from cutting their nails indoors, less they should thereby incur misfortune.

This portion of the paper may be fittingly closed by a reference to Hindu ideas about celestial bodies and natural phenomena. The planet Mars has a disturbing influence on the earth, which tends to produce wars and other political disturbances. This tendency is at present intensified by the existing conjunction between Mars, Saturn, and Jupiter, to which is attributed also the spread of plague. The approach of Halley's Comet was thought to indicate impending famine and pestilence, and also, so a Hindu friend has lately informed me, danger to the House of Lords. A Sadu lately appeared before a Calcutta police-magistrate asking that the dispenser of justice would order him to be sacrificed to the Goddess Kali so that the evil influence of the comet might be averted from the Government and people of India. Sad to say, his public-spirited offer was declined. Saturn has an evil disposition, and will blight the prosperity of anyone who falls under its evil eye for seven years unless in the meantime he induces a Brahmin priest to interfere. This, of course, costs money. Venus, the universal mischief-maker, is also an unlucky star, and the day of the week named after her, Shukrwar, Friday, is an unlucky day. Eclipses of the sun are due to the fact that the radiant orb is from time to time so shocked at human enormities that he hangs his head in sheer despondency. But eclipses of the moon occur because her ladyship is being dunned for debt by two supernatural ogres named Rahu and Ketu. To hasten payment they threaten to swallow her, and to obviate her extinction the pious offer up prayers and propitiate Mangs with presents, because Rahu and Ketu are of the Mang caste. After the eclipse is over, devout Hindus bathe and break their earthen pots as after a funeral. Comets and shooting stars portend the birth and death of princes. The rainbow is the bow of Indra shooting forth arrows of welcome rain over the thirsty land. Volcanic eruptions indicate the wrath of the God Shiva, the destroyer. Finally, earthquakes occur because the great cobra, on which the earth rests, moves his head to manifest the displeasure of his lord Vishnu, the preserver, at the misdeeds of men.

SUPERSTITIONS COMMON TO INDIA AND EUROPE.

And now I reach the last stage of our progress —that of discussing the superstitions common to India and Europe. Take the custom of blessing a man when he sneezes. Indians say "Live long!" Germans, "*Gesundheit*" (good health to you), and Frenchmen, "*À vos souhaits*" (I wish you well). This custom is said to be due to the fact that the first symptom of the Black Death of the Middle Ages was a fit of sneezing. Could that destroying epidemic have been a virulent form of the modern "'flu"?

Both Indians and Europeans draw omens from birds. Thus in France, if a stray bird enters a house the omen is good, and so in India the arrival of a stray pigeon brings luck. In both East and West the owl's hoot and the dog's howl are sounds of ill-omen. Italy shares with India a belief in the evil eye, and the same belief underlies the English practice of throwing an old shoe after a newly-wedded couple. Again, in India a horseshoe is a safeguard against evil spirits, while in England to find an old horse-shoe brings good luck. On the other hand, it is very unlucky to break a mirror whether in Europe or India. This belief is said to be due to the idea that injury is thereby caused to the "other self" appearing in the glass. Various Indian jungle tribes believe that witches can transform themselves into animals, and the same belief used to prevail in Yorkshire and Devon. But the Indian witch prefers the splendid similitude of a tiger, while her British compeer was content with the humble form of hare or cat. In France the witch was supposed to assume the dreadful shape of the child-devouring were-wolf. Finally, comets are believed both in Asia and Europe to portend the death of royalty.

Shakespeare himself wrote the lines—

> "When beggars die there are no comets seen.
> The heavens themselves blaze forth the death of princes."

Thus the minds of men, especially untutored men, Eastern or Western, in many ways evince their common origin when moved by deep-rooted

instincts and emotions. In the words of the prince of poets—

"One touch of Nature makes the whole world kin."

[P.S.—Mr. Gupta, in the course of the discussion that followed the reading of this paper, stated that he had never heard in Bengal of the superstition that Europeans had the evil eye or the belief that the English were descended from Hanuman, the Monkey King. I hesitated to dispute his authority myself, but I may say that after the proceedings had terminated a highly intelligent Bengali gentleman of my acquaintance informed me that he had heard of both these ideas in Bengal, and that they were prevalent among both Hindus and Mohammedans of that province.]

DISCUSSION.

The CHAIRMAN (Lord Lamington), in opening the discussion, said the Society was very much indebted to the author for his valuable compilation of the various superstitions prevalent in India. It did not do for people in this country to laugh or mock at other people's superstitions, because he believed that in the very latest of the Atlantic greyhounds there was no stateroom numbered 13, owing to the dislike of travellers to occupy berths designated by that particular number. The author had stated that the people of India who were supposed to possess the evil eye, and who were something in the nature of witches, were not to be judged by outward appearance. That was contrary to the feeling that used to exist in Europe, because all witches were supposed to be ugly, hideous, and, generally, hags; but Indian beliefs were rather more practical. Personally, he fancied more harm had been done in Europe by the good-looking witch than by any old hag that ever existed. The author had mentioned certain people whose spirit, when they went to sleep, was supposed to go out of the body and very often liked to go to a water-jar to get refreshment. Having travelled in New Guinea, he could remember when one of the party went to sleep in a boat, and for some reason it was required to wake him, none of the boat's crew would venture to do so, because it was supposed that when a person was asleep the spirit left the body, and if the body was disturbed the possessor of that body would invariably die. The author had referred in the course of his paper to the superstition prevalent in some parts of India, that the foundations of large masonry works could not be well and truly laid without a human sacrifice. He had an example of that superstition when he had the honour of being Governor of Bombay. It was the occasion of the visit of the then Prince and Princess of Wales to India, and their Royal Highnesses were to lay the foundation-stone of the great new docks which were to be built. He suggested that there should be a gathering of children to commemorate the occasion, but his idea was overborne by the criticism that if any child happened to get lost, which might easily occur in such a large gathering, it would be said that that child had been taken to be imbedded in the masonry work of the great docks. The author had referred to the question of earthquakes, and had stated that a prophecy made by someone of an earthquake taking place proved to be false. He remembered two years ago meeting a lady, whose veracity he had no reason to doubt, who stated she was so sensitive to changes in the atmosphere that she could always foretell an earthquake two or three days before it occurred. For instance, she was aware that the great earthquake in Messina would take place two or three days before it actually occurred, and when the occurrence took place she again had peculiar sensations or effect upon her body which the shock or changes in the weather always brought about. There might, therefore, be something more in the statement of the prophet than Mr. Moore was disposed to credit him with. Superstition, from his point of view, was a very material form of religion. A few years ago a book called "Myths" was published, which dealt with superstitions amongst the Australian aborigines, and the purpose of the book was to show that belief in superstitions in default of any real religion was of very great value indeed, that superstitions tended to give a certain stability and a certain idea of morals amongst the people, and were not to be lightly condemned. It was naturally a very material belief—a belief that by something happening to the body, or some occurrence, or some manifestation to the senses, either evil would come or good would be brought about. True religion was the exact converse of that. True religion said that what was apparently material was immaterial, that the soul and the unseen were the matters of vital concern to all. At the same time, superstitions did no doubt inculcate a certain principle in people, although when they were carried to extremes they were distinctly hurtful—as, for instance, the custom of human sacrifice. With regard to the question of the credibility of superstitions, he did not suppose anyone present really believed in them, but yet it was an extraordinary thing that, though people did not believe in them, the thing connected with the superstition very often did happen. Lockhart, in his "Life of Scott," mentioned how Mungo Park, when bidding farewell to some of his friends in this country for the last time, felt sure that he would never return, and surely enough he perished in Africa. There might be something in the proverb quoted in that book, "Freits attend those who heed them." Belief in material superstitions seemed to be quite contrary to the highest idea of Indian religion.

Sir GEORGE BIRDWOOD said:—As for criticism of Mr. Leslie Moore's delightful paper, he had nothing but praise to dispense. Mr. Leslie Moore had brought before them an immense mass of rare and refractory, indeed, almost intractable knowledge, gathered "from a far country," for the

greater part at first-hand by himself, and had presented it to them in the simplest and clearest language, as if he had copied it all out from private letters, written by him in India to friends in England: and had read his paper with an ease and force of enunciation quite exceptional among those who usually dealt in public with such impracticable themes, thus adding greatly to the gratification of his distinguished audience that afternoon. Mr. Leslie Moore might indeed rest assured that the volume of the *Journal of the Royal Society of Arts* containing his most praiseworthy paper would always remain a *locus classicus* on its seductive, if limitless subject.

For the rest, his own remarks would be directed primarily to the enforcement of the fact that Indian superstitions were not such a trackless wilderness of random beliefs, rites, customs, fairy tales, and often inexplicable "survivals," as were the corresponding and, in origin, identical superstitions of Europe, wherever the evolution of the spiritual life of the people had been disturbed and checked by religious revolutions; but consisted of a body of systematised, and, for the most part, even after 3,000 years, readily explainable, and, indeed, quite rational traditions and regulations, the binding authority of which is still unshaken in India—India of the Hindus—and, consequently, still plenipotent to quicken the vitality, and assure the stability of a unique, and as he (Sir George Birdwood) trusted, ever irresolvable idiosyncratic civilisation, based on an hieratic social economy of the highest ethical elevation and beauty in its ideals, and in its realities of boundless beneficence and grace—the grace that begets grace [Χάρις χάριν τίκτει].

"Superstitions," albeit limited by the qualification "Indian," was, as Mr. Leslie Moore acknowledged in opening his paper, too comprehensive a title for it; for superstition is the natural attitude, in fear, and awe, and reverence, and adoration, of finite man, before, to him, through his five senses alone, the unknown and unknowable Infinite; and includes all religions,* their dogmas, rituals, rules of conduct, etc.; all, from the most debased to the most exalted, being, in their time and place, equally reasonable and well-founded, and rightworthy, and obligatory; and essentially one and the same religion,—and of one and the same man; in accordance with the natural law of absolute unity in, and throughout exhaustless and incalculable diversity. Even in restricting himself to "Indian Superstitions," Mr. Leslie Moore had not attempted to enlarge on any but the most ubiquitous, and conspicuous, and popular of them, such as Omens, the Evil Eye, Spirits, Marriage Usages, and Magic. He (Sir George Birdwood) would confine his observations entirely to omens, and in the narrowest, practical application of the word omen; difficult as it is to discriminate, theoretically, between omens, and divination, vaticination, and prophecy.

* Cicero, Nat. Deor. xlii., defines superstition as, "a vain fear of the gods," and religion, "a pious adoration of them." But fear has been our schoolmaster to bring us, step by step, to the adoration, and the love of the Creator; in its perfected form, the love of all fellow-creatures, even of the brute creation: and that is Buddhism—and Buddhaized Hinduism!

The etymology of the word omen is now regarded as uncertain, and indeed, undeterminable; and although himself convinced that it sprang from a root in common with the Greek ὄρνις, "a bird," and "an omen," and again οἰωνός, "a solitary [flying] bird," such as the eagle and vulture, and "an omen," and that it therefore referred originally to omens derived from the observation of birds, he would nevertheless use the word, in the present connection, only in its now largely-extended meaning, as generically including every recognised species of omen for the disclosure of future fates of good and evil,* viz.: (1) Auspices, or presages [*cf.* sagacious], portents, ostents, *monstra* † or "warnings," etc., from the "inspection" of the flight and feeding of "birds." (2) Aruspices, i.e., Haruspices, or foresights, forebodings, etc., from the "inspection" of the "entrails" [*hira*, "empty gut," *cf.* Sanskrit, *hira*, "intestines"] of "birds" [and other "victims," *haruga*, from *harviga*, or *arviga*, meaning *hostis*] sacrificed for the purpose. (3) Auguries [*avis*, "a bird," and *garrire*, to chatter, etc., compare "gargle," Night-Jar, and Jay], or prodigies, wonders, foretold by the chatter, cry, and song notes, and singing of birds, etc. And (4) Oracles, or pre-"dictions," announced, usually in response to inquiries, by the gods; including the forecasting of future events by the drawing of lots [*sors, sortis*], turning to passages in books opened off-hand ["Sortes Homericae,"

* As to the original meanings — which I have above attempted clearly to bring out—of these œonological words, one etymology of "omen" goes back to the hypothetical Aryan root *av*; found in the Sanskrit *avi*, "observing," and *avas*, "favouring"; the Greek οὖς, and αὖς, "the ear" [also αἰσθητικός, "sensitive"]; the Latin *Ave*, "Hail!" *avus*, a "grandfather," *auris*, "the ear," *osmen* or *omen*, for *aus-men*, "a thing heard"; and the English [Norman] "Oyez!" audacious, and scout, words all referring to listening, and [Boer] "Oom," or Old-Man, in a reverential sense, as in "Oom Paul." On the other hand, the passages in Varro are quoted:—"*omen velut oremen*," and "*quod ex ore primum elatum est osmen dictum*." Hence Skeat says, some connect it with *os*, "the mouth," others with *auris*, "the ear." The words "auspices" and "auguries" are referred to the hypothetical Aryan roots *va* and *vi*, appearing in the Sanskrit *vaga*, "wind," Vayu, "Wind God," *vara*, "tail"—for fanning, as the yak's, and peacock's, and *vigh*, "bird"; the Greek οἰωνός [which I take to be cognate with "omen"]; the Latin *vagabundus*, "a vagabond," *vage*, "sparsely," "vaguely," "far and wide," *ventus*, "wind," *vannus*, "a winnowing fan," *avis*, "a bird," *auspicium*, divination from the flight of birds, and *augurium*, from the sound of birds; [and the English wind, winnow, winter, wither]. "Oracle" goes back to the Latin *os, oris*, "the mouth," as possibly, as will have been seen above, does "omen," from which we get the Latin *orare*, to pray, *adorare*, to pray to, and *orator*, "an eloquent speaker." In any œonological association, there is no word derived from the Greek ὄρνις; but its root is considered to appear in the Latin *ulmus*, "the elm," *alnus*, "the alder," and *ornus*, "the mountain ash," and the English [Scotch] "rowan-tree," or said "mountain ash," and in "ornithology."

† Cicero, Divin. xlii., says,—omens are distinguished as "ostenta, portenta, monstra, prodigia," because "ostendunt, portendunt, monstrant, prædicunt."

"SS. Biblicæ,"* "SS. Virgilianæ,"† etc.], and the calculating of nativities from the rising of the "Sidus Natalitium" by astrologers.

In India, omens thus discriminated and classed are a division of the sacro-sanct science of *Jyotisha*, or Astronomy; so called from Jyoti, "the Shining," one of the epithets of the Lord Siva; and every Hindu who aspires to a redeeming mastery of "the four Vedas," or Books-of-Sacred-"Knowledge" [*cf.* "wisdom," "wit," "witch," etc., and the Greek εἴδωλον, "an image," ἰδέα, "idea," and Latin *visus*, "vision," and *videre*, "to see"] has concurrently to study "the six Vidangas," or "Bodies" supplementary-to-the-"Vedas"; of which "Astronomy" is the most widely known, including, as it does, mathematics, astrology, horoscopes, omens, and palmistry. Every Hindu village has its hereditary *Jyotishi*, *Joshi*, or Astrologer and Diviner, and, indeed, its general guide, philosopher, and friend: who each successive year writes up the Kalendar [*Panchanga*, "the Five Bodies," i.e., "topics" of the lunar, and the solar days, the lunar asterisms, the division of the lunar days, and the transits and conjunctions of the planets] by which all religious festivals and other solennial observances are fixed, and all agricultural operations regulated, and wedding-days are arranged, and nativities cast, and fortunes foretold, and omens in general are interpreted. He combines in himself the Roman Astrologus, Mathematicus, Genethliacus, Horoscopus, and Auspex Nuptiarum, Haruspex, and Augur. In a word, he is the village Oracle; and delightful good company, with his hid treasure of priceless ancientries, for every distinguished stranger passing his time-worn way, if but he can speak your language, or you his. In view of the ignorant detraction of him, and his tribe, by the more illiterate class of our Protestant missionaries in India,—thinking of the dictum of Julius Hare, "The Christian is God Almighty's Gentleman," he (Sir George Birdwood) always read it, "The Gentleman is God Almighty's Christian"; a version, after all, nearer to the original line in "Absolom and Achitophel," "His tribe were God Almighty's Gentlemen." Of course his sacred office, that rightly can be held only by one of "the twice-born castes," lends itself to charlatanry and roguery of every degree; and therefore its incumbents are expressly forbidden to interpret omens, as they are also forbidden to teach the *Shastras*, "Vedangas," and Vedas, for a fee; while those who do so, and those not of the four "twice-born castes" who usurp the office, are numbered with informers, horse-trainers, dog-fanciers, teachers of fencing, etc., and are universally despised, just as by the Romans was "the starveling Greek" of their high day [Juvenal III.] who played the part at once of—

> Grammarian, painter, augur, rhetorician
> Rope dancer, conjuror, fiddler, and physician.

Strictly speaking, the regular, hierarchical *Jyotishi* or *Joshi* should be a Brahman; and in Hindustan is generally a Brahman, but in the Dakhan he is almost everywhere a Sudra. The great book in the Dakhan on Auspices and Auguries is the *Pancha-Paksha-Shastra*,* or "Five-Birds-Canon," that is, "Rule of Divination, by the Cock, the Crow, the Kite, the *chakora* or "Indian Cuckoo," and the Peacock, and, in practice, any other "kenspeckle" bird: and it is interesting to note that among the Romans the principal birds that gave omens by singing [*oscines*] were the raven [Apollo], the owl [Minerva], the crow, and the cock, and by flight [*alites*, or *præpetes*], the eagle [Jupiter], vulture, hawk, screech-owl, osprey, and buzzard [*cf.* Statius, "The Thebaid," iii. 502 *et seq.*: Cicero, Divin. liii.:—"Tum hic, tum illuc volent alites; tum a dextra, tum a sinistra parte canant oscines:" also the footnotes by J. Tollius, in Blaev's edition of Ausonius, Amsterdam, 1671, pages 489–90, on the line in "Technopægnion":—"Quadrupes oscinibus quis jungitur auspiciis?—Mus."]. But having been very much preoccupied while in India as Honorary Secretary to the Agri-Horticultural Society of Western India, in laying out the Victoria Gardens in Bombay, and carrying out their agricultural experiments at Poona, his (Sir George Birdwood's) greater interest while so engaged was in the œonology of Indian plants. There is no Indian canonical *Shastra*, or Book-of-"Instruction," on arboreal and floral omens; but in the works on astronomy, or *Jyotisha*, attributed to Varauha Mihiram, the one of "The Nine Gems of the Court of King Vikramadilya" who is credited with the statement that "sun-spots are ominous of imminent famine," numbers of omens from plants are given. He (Sir George Birdwood) had never seen any of this mythical Varauha Mihiram's writings, such as the *Brihat Samhita* ["Treatise" on the planet "Jupiter"], and the *Brihaj Jataka* ["Treatise on Nativities"], but many of its omens became known to him through Dr. Bhau Daji and the Rao Sahib Vishvanath Narayan Mandlik, and the Hindu Superintendents [*Karbaris*] of the Bombay and Poona Gardens; and nearly all of them relating to plants were in this form:—If such and such a "kenspeckle" wild plant were at any time in such and such a condition, such and such would be the following fate of the crop, tree, or flowering plant in which you were interested. For example:—"If bent grass flowers, there will be a great crop of sugar-cane." Others were of wider scope, as in

* The *Bathkol* of the Jews, according to Sir R. P. Jodrell's "Illustrations of Euripides."

† Charles I., in some conjuncture of his troubles, turning to his Virgil, opened it at Æneid iv. ll. 615 *et seq.*, and, in the doating Dido's furious cursing of her fugitive lover, read, in its full malignancy, his own foredoomed and irrevocable fate.

* Not to be confused with the Panchatantra, "Five-books," compiled in the 5th century A.D., by the Brahman Vishnu Sarman; but originally, in all probability, a Buddhistic work, it being nothing less than a veiled attack on the Brahmans. We know it best in the form of "Pilpay's Fables."

the following illustrations:—"If the *Champaka* flowers well, every crop will do well":—"If the 'Mango' fruits prolifically, every one will prosper":—"If the Wood-apple flowers, there will be storms about":—"If the Marking-nut flourishes, there will be fear in men's hearts of evil to come": —"If the Catechu spreads itself out and blossoms abundantly, there will be famine in the land":— "If the *Barringtonia speciosa* richly blooms, plague and pestilence will follow":—"If the Blue Lotus flowers, the country will be invaded by a foreign army." Obviously such omens are not idle and vain mystifications, or again, arbitrary "survivals," and gradually he (Sir George Birdwood) became convinced that they were founded on an overwhelming induction of facts, observed with untiring solicitude, albeit imperfectly observed,—judged by our present scientific standards of research,—and from generation to generation, and century after century, through at least three millenniums; and that they were just as honest in intention, and true in inspiration, as the forecasts of solar and lunar eclipses, and planetary occultations, and the dread visitations of comets. He (Sir George Birdwood) would not say this of the following plant omen:—"If the Sarsaparilla flowers well,—dancing-girls will have a fine high time of it." But at least this may be said of all widespread and enduring omens of the sort, that, although they have outlived their original significance, and become useless for all the practical purposes of a work-a-day world, and apparently unmeaning "survivals," the observance of them is still of advantage,—in the promotion of the continuity of folk-lore, and folk-culture, and of that reverence for the past which is the groundwork of all culture, and above all, as "means of grace" in the evolution of spiritual-mindedness, among the peoples who from the darkmost abysm of the past, have grown up with them into the wider spread, and, we will hope, brighter and happier light of the present-day world.

Mr. Leslie Moore has well shown how closely the omens of the Hindus resemble those of other races,—not only of the Japethic or Aryan race, but of the Semitic and Hamitic. The truth is, that the most notable of them have come down to us from millenniums before the division of the once universal, so-called Scythian, race, or Noachians of the Old World, into Semites, Hamites, and Aryans. Sneezing has always been regarded as a strong omen, and, in the main, for good. The Bible is full of reference and allusions to astrologers, charmers, diviners, exorcists, magicians, sorcerers, soothsayers, oracles,* but all through it, including the Apocrypha, no one sneezes. In the "Odyssey," xvii. 541–5, we read how Penelope, at first doubting the story of the return of Ulysses, disguised as a beggar, on Telemachus at the end of it giving "a great sneeze," regarded as a confirmation of its truth, and instantly cried out exultantly:—"Come, call in the stranger, that not one be spared of the suitors to be slaughtered." Aristophanes in "The Frogs"—on Æacus crying out to Bacchus:—"Assuredly I struck you," makes Bacchus reply:—"Then why did I not sneeze?" And in "The Birds"—we read:—"With you a word is 'a bird,' and you call a sneeze 'a bird,' a sudden meeting 'a bird,' a servant 'a bird,' an ass 'a bird'" [*i.e.*, they were each one an omen, or ὄρνις—as in Latin are *avis* and *ales*]. Theocritus, viii., has:—"On Simichidas the Loves have sneezed"; and, xviii.,—the "Epithalamium of Helen":—"O happy bridegroom, some benignant spirit sneezed on thee a blessing." Catullus, xlv., on Acme and Septimus, records:—"Love who at first had regarded him [disdainfully] from the left, now sneezed approvingly from the right": and similarly sealed Acme's passion for Septimus with another "sneeze from the right." Propertius, ii. 3, asks:—"In thy new born days, my life, did Love sneeze, sharp and clear, a favouring omen?":—

"Aridus argutum sternuit omen Amor?"

Pliny, ii. 40 (40) tells us that at the rising of the Dog Star, the Egyptian Oryx stands facing it, steadfastly sneezing at it, as if worshipping it. Again, xxviii. 5 (2) he asks:—"Why when one sneezes do we salute him? an attention the Emperor Tiberius Cæsar, the most dismal of men, invariably exacted from those about him." That is quite a Gilbertian "scena"! The Greek salutations were "Ζῆθι!"—"Ζεῦ, σῶσον!" [Ausonius, "Griphus," p. 455]. "Deus te adjuvet" was the Latin one of Mediæval Europe; the German Mr. Leslie Moore has given us; and we all knew the English:—"God bless you." Indian œonology is full of sneezing; and a common saying among Hindus, when anyone suddenly, and for no apparent reason, changes his mind, is:—"Did a fly sneeze?" It is worthy of being naturalised in Europe, if, indeed, it is not already domiciled there somewhere. Also it is a great social art among Indians to convert a bad into a good omen, after the manner of Julius Cæsar, of whom Suetonius [59] tells us that stumbling—a direful portent—on the seashore, when landing with his invading army at Adrumetum, he at once kissed the ground, and, at the same time gathering up a handful of the soil, exclaimed triumphantly as he arose to his feet:—"Thus I take prize of Thee, O Africa!"

The close relationship of the omens of the Greeks and Romans to those of the Hindus is, of course, due not only to the prehistoric connection between them before they migrated from their original home—somewhere about the Caspian Sea—Westward and Eastward, respectively, but to the interchange of omens among them, after they had become separate, and great, and renowned nationalities, with differentiated languages, literatures, arts, and religions; an interchange that had grown so intimate by the period of the Cæsars, that Armenius, Babylonius, Comagenus, Chaldæus and Indus, were then Roman synonyms

* II. Samuel xvi. 73:—"Oracle," means, "The Word of God": in the New Testament invariably the Mosaic Law.

for *astrologus*, *auspex*, *augur*, *haruspex*, etc.; and, as he (Sir George Birdwood) had often said before, the glory of the reign of Augustus Cæsar and his immediate predecessor and successors, that was above all the glory of Cicero and Virgil, and Horace, and Ovid, and Pliny, etc., became reflected throughout India by the still vivid and vitalising legend of "The Nine Gems of the Court of King Vikramadilya." And some day it will be demonstrated that the legendary Varauha Mihiram, of whom he had already spoken was, in the flesh, none other than his own first and last official and journalistic inspiration and despair, the Elder Pliny,—amalgamed, in diminishing proportions, with Cicero, the philosophical Augur, and Claudius Ptolemy the Geographer, and Astronomer, and Aratus, the Laureate of the Heavens:—

"In restless Gyres about the Arctic Pole."

Mr. K. G. Gupta, C.S.I., said he could not understand how it was that an Indian had been asked to speak, unless it were a cunning device of the Secretary to present before the audience a live specimen of that unfortunate people called Hindus, who had been credited with the long catalogue of superstitions with which the author had regaled them. He wished the author had placed some limitation upon the word Hindu, because he evidently referred to what he had learned in his experience in Bombay. Many of the observations which were made with regard to the Hindus generally did not apply, at any rate, to Bengal from which he (the speaker) came. He would take only two examples to prove that. The first was when the author said that the European was credited with the evil eye. Personally he had never heard of it in Bengal, where he was born and brought up, and lived for many years. But there might be a reason for having that belief in some places because of the difference in the customs of England and India. All those who had been in India knew that Indian mothers did not like their children to be praised in any way; they did not like them to be called plump, sweet or healthy. But in this country the custom was just the reverse. If anyone wished to please a mother, he could not do better than bestow commendations on the child. It might have happened that in India some English lady, not knowing the Indian custom, might have spoken well of the children of her hostess, and the hostess had taken the compliment in a different light. It was quite possible that, by a strange coincidence, some harm had befallen the children, so that one could easily understand how a European would be credited with the evil eye. In the second place, he had never heard the suggestion made previously that an Englishman was regarded as a descendant of Hanuman. Having regard to the extreme energy of the average Englishman, his agility in the tennis-court, or cricket-field, or in the ball-room, it was possible that in some parts of India he might be considered as being descended from the ape. In that connection they were on very solid ground, because, according to the most approved theory, they were all descended from apes, and he, therefore, thought the Hindu gave the Englishman very great credit, because he did not regard him as a descendant from an ordinary ape, but from Hanuman, the Lord of Monkeys. Hanuman was the ally and friend of Rama, one of the great Indian deities; he assisted Rama in civilising and Aryanising Ceylon, and he was a loyal, thoroughly good and kind ape. He was so loyal that when his loyalty was once questioned he tore open his breast for everybody to see that on his heart was written the name of his friend and patron Rama. If they had to admit that they were descended from apes, surely the best thing that could possibly happen was to be descended from the best of the apes, so that there was nothing discreditable about it at all. Coming to the question of superstitions, what were superstitions? Did not they represent the exercise of that faculty which had brought all human knowledge, *i.e.*, the inductive faculty? All the highest achievements of science were due to that process. Superstition was an inference drawn from one or two coincidences. It was faulty in that sense, but it was the result of the same process. It could easily be imagined that, in the early days of humanity, when a hunter started out in the morning to find food for the day, he saw a jackal on his left-hand side, and that on that day he was unsuccessful. The next day when he started out the jackal was not there, and then he was successful. On the third day, unfortunately, the jackal happened to be there, and again he met with failure. Naturally he would go home and think that the jackal on his left-hand side must have had something to do with his non-success. He would tell that to his friends and relations, and so the superstition would gradually get abroad. Probably some other men would have the same experience too, and it would be regarded as a fact inductively proved. There was the jackal, and there was the want of success on three or four or five occasions; therefore their relation as cause and effect must be a fact. That instance of inductive reasoning was no doubt faulty, but once the superstition was well established those who believed in it did not take heed of the want of proof in other cases, but only took note of those cases where the coincidence happened. It was due to the inductive process hastily carried out and the naturally innate conservatism of the human mind that superstitions had gradually grown up and spread. And, after all, what was true to-day might be superstition in the near future. For instance, in the highest principles of science, what people believed to be perfectly true to-day, fifty years hence would probably be called superstitions. As knowledge progressed, the theories which were held to be absolutely proved at the present time would in a generation or two be regarded as quite superstitious. The word superstition did not carry one very far. What was called superstition really represented different stages of ignorance. As

people grew in intelligence they left superstitions behind. They had done their work for the day, and they were doing their work now for different stages of society. All people were not on the same level of culture, enlightenment and education. Those who were still children could not be taken straight away to the university and given the highest education. Similarly, human beings who had not yet advanced forward liked to play with what more cultured people regarded as superstitions, although they would gradually overcome them as education advanced and enlightenment grew. It was not right to laugh at superstitions, because they were doing their work for the time, and they would be gradually discarded as any particular class of people or race advanced in enlightenment. In that way he thought superstitions had their uses. The particular superstitions to which the author had referred did not, he thought, have very much to do with religion; they related to actual experiences in life, and had not so much to do with the spiritual side of life and what would happen hereafter. That was another kind of superstition with which he did not think the author had dealt.

Mr. M. Longworth Dames said his own experience in India had been in an entirely different part from that dealt with by the author, namely, on the North-West Frontier. As most of those present knew, beliefs varied in different parts of India, but there was often quite as much in common between the beliefs of a country as there was between the beliefs of entirely different countries. Many of the superstitions to which the author had referred could be paralleled just as well in Europe or other parts of the world. He called to memory a belief which was held about the Bhuts on the North-West Frontier. There was a place not far from his house which was believed to be haunted by a Bhut, and which it was dangerous to pass by at night. A man went past it one night and was then found to have a hump on his back, the statement being made that the Bhut had jumped on his back and stopped there. There was also an Irish story of a man who passed a haunted castle, when the Phuca sprang on his back and stopped there, and he became a hunchback. The author had referred to the superstition of eating the earth from saints' graves. He came across a similar case in Ireland, in King's County, where the people of the district visited a priest's tomb and were gradually eating all the earth from that tomb. He remembered also a particular kind of omen that existed among the Baluchis on the North-West Frontier. According to the Baluchis it was a very unlucky thing to see a particular bird, a sort of shrike, on one's left-hand side on starting a journey. Should such a bird be seen it was necessary for the travellers to go back and make a fresh start. But if the party happened to be going out shooting it was a favourable omen to see the bird on the left-hand side, because it meant blood, and the shooting party could proceed. He remembered once receiving an official report from the local police officer in the district he was administering saying that a widow and her family, who did the scavenging for a small bungalow in the district, had been driven out of their house by a Djinn. His orders being requested on the subject, he told the officer to provide another house for the widow and her family for the time being. When he visited the place he heard the statement of the widow and of the surviving children, one of the children having already been killed by the Djinn, while the others were perpetually frightened out of their lives. They lived under a small stunted tree, the hut being almost under the boughs of the tree. The children used to play under it, but whenever the mother was away the Djinn used suddenly to spring out and dreadfully frighten them. He (Mr. Dames) proposed to cut down the tree, in order to remove the Djinn, but his proposition created the utmost consternation, because the people said the Djinn would take a frightful revenge. Accordingly the house remained unoccupied, and a separate house had to be provided for the widow and her children. Another curious belief in that part of the country was that the Djinn sometimes took the appearance of devils seen travelling across the plains in hot weather. As a rule Mohammedans believed they were the souls of unbelievers, especially Hindus, who were compelled to live a wandering life as they had never accepted a proper faith. Personally he had seen ten or a dozen columns of dust and sand crossing the plain at the same time, and they certainly had a very ghostly appearance.

Mr. K. Vyasa Rao said he had always tried to look at Indian superstitions from the point of view of the outsider. It struck him that Indian superstitions had in them a basis quite different from the basis of superstitions that existed in other countries. One very interesting superstition which the author had not mentioned was that in regard to pollution. When a death occurred in a Hindu household the members of that household, even though some of the relations might be living hundreds of miles away, had to observe pollution for ten days. That rule was nowadays seen in the wholesome principle of segregation, because during the time of pollution no member of the household was permitted to enter a house, or to be in any sort of social communion with the members of that house. When the plague occurred in Bombay and other places in India, the principle of segregation was carried out in exactly the same way, but that principle of segregation had been thought of and adopted centuries ago in India. Another great superstition to which the author had referred was in regard to the occurrence of an eclipse, it being thought that the eclipse of the sun and the moon was due to two snakes or serpents. Whenever an eclipse took place Hindus were compelled to go out of their houses to the rivers and tanks and have a bath, just at

the time the eclipse began and concluded. It would be found that two thousand years ago Indian astronomers were so well acquainted with astronomical matters that they were able to fix the time and place of an eclipse, and nevertheless by the side of such great scientific ability there was such a silly superstition, in which people believed, as that two snakes came and swallowed the sun and the moon at the time of an eclipse, and that they must, therefore, go and have a bath. The reason that the people had a bath at the time was that they feared during the eclipse there might be some seismic disturbance, and that it would be a precautionary measure on their part to leave the house and be in the open at the time. Another superstition to which the author had not referred was the wonderful power certain Indians possessed in the art of curing snake bites and scorpion stings. If a man was stung in the ankle the poison gradually ascended his body; but as soon as the poison-curer began to pour out his incantations, the poison in the armpit began to descend and go slowly down until it came to the actual spot where the original sting was, and then it disappeared altogether from the place of the sting. That was done even at the present day, and no scientist or psychologist had been able to explain the wonder of it, or how it was possible that a man, simply by means of incantations, was able to get rid of poison in another man's body and altogether relieve him of illness. Under the name of superstition there were sterling gems of the purest ray which would lead to a better appreciation of spiritual beliefs.

Sir ARUNDEL T. ARUNDEL, K.C.S.I., in proposing a hearty vote of thanks to the author for his interesting and instructive paper, said he thought Mr. Gupta's contribution was one of extreme value, as it endeavoured to get at the underlying principles of the superstitions to which reference had been made. He wished to be allowed to refer to one curious experience in regard to the superstition that existed as to the killing of human victims for placing in the foundations of bridges, to which the Chairman had referred. Near the place where he was Collector, a large bridge was being built across the River Kistna. There was a great dam across the river, and a broad canal, which severed the town from a large stretch of land between the canal and the river. Rumours had been going about in the town, for some time past, that sacrifices were to be offered. It was even rumoured that the engineer-in-chief, Mr. Spring, had had a letter from the late Queen Victoria mentioning the number of babies who were to be put in the foundations of the bridge. In the tract between the canal and the river there was a large colony of Punjabis, who had been imported specially by Mr. Spring to carry on the work, and a number of those Punjabis used to go over a narrow bridge, leading across the canal, into the bazaar, and buy what they wanted. One of them was in the bazaar one morning, and seeing a woman there selling sweetmeats, he went and bought some from her. The woman had a baby in her arms, and in order to ingratiate himself with her, the Punjabi took the baby in his arms purely for that purpose. He had no sooner done so than a woman on the other side of the bazaar shouted out, "Baby snatcher!" and in a moment the whole town was in an uproar. The argument of the villagers was that one of the Punjabis had actually been seen with the baby in his arms, and that the sole object for which he had possession of it was in order that it might be sacrificed to be put in the foundations of the bridge. The uproar was on the point of turning into a great riot, but it was ultimately quelled through the tactful interposition of the chief engineer, assisted by the native magistrate, who had to be fetched from some distance.

Sir JAMES WILSON, K.C.S.I., in seconding the motion, related an instance in which he had the misfortune to come into conflict with a Bhut. In some parts of the Punjab there were large *tumuli*, ancient burying-places, which were supposed to be the graves of the *naugajas*, giants who were nine yards long. On riding into a new camp one day, a little to the north of Delhi, he was met by a deputation of the headmen of the village, who were evidently greatly disturbed. They explained to him that his tent-pitchers had unfortunately pitched his tent close to one of the graves of the *naugajas*, and that they did not like it at all. He replied that he was very sorry to hear it, and that, if they objected because they thought it was a holy place, he would give orders to have the camp removed. The headmen replied that it was not a sacred place, and that personally they did not mind, but they were afraid of the consequences to him. They explained to him that the *naugaja* was a very dangerous person, and that he would probably resent anybody trespassing upon his ground; but he (Sir James) replied that, if that was all, he would risk it. In the middle of the heat of the day there was a tremendous uproar in the camp, and on making inquiry he discovered that a rotten tree standing in the middle of the camp had suddenly caught fire most mysteriously. All the people and his own servants swore that nobody had gone near it, and that the outbreak was the giant's first indication of the trouble he intended to bring upon them. In the middle of the night a whirlwind blew right through the camp and very nearly blew his tent down; the Government official tent was blown down, and the Government official table was broken. The villagers, of course, put that down to the action of the *naugaja*, and he had no doubt they were still more convinced than ever before that the *naugaja* was a dangerous fellow.

Sir GEORGE BIRDWOOD said he rose simply to confirm Mr. Leslie Moore's statement that the belief prevails among the Hindus, at least in the Presidency of Bombay, of the English being

descended from the Indian Monkey God, Hanuman [" Long-jaw "]; but whether it was to be regarded as implying compliment or contempt would depend on the feeling and thought of the person at the time of giving expression to it: for the Hindus, like all the quick-witted people of Southern Eurasia, from Greece to India, have a wonderful way of conveying praise and blame, blessing and cursing, in the same words; of which the best illustration, albeit unintentional, known to him, was the "Authorised Version" of the Biblical text:—"O fools and slow of heart to believe all that the prophets have told you." The "Revised Version" is even more clearly double-edged, and is only to be rightly understood by substituting the word *after* for "in" between "to believe" and "all." It is the Hill Tribes of South-Western India who are personified in "The Ramayana" by the simious subjects of the heroical Hanuman; and spoken by a Hindu, in the plain sense of the words, the tradition referred to by Mr. Leslie Moore could have been repeated to him only in the spirit of the sincerest praise. A common Hindu saying in Bombay is:—"Even the High Gods themselves delight in flattery." *

Mr. Leslie Moore, in replying to the discussion, said Mr. Gupta was perfectly right in saying that he (the author) was not careful enough in using the term "Hindu." He ought to have said "Bombay Hindu" more frequently than he did. Sir George Birdwood had supported him in the statement that Englishmen were descended from Hanuman, the Monkey God, and Mr. Gupta had pointed out what a glorious ancestry that was. Mr. Gupta had stated that the evil eye superstition did not exist in Bengal. It certainly existed in Bombay, and he thought that it must also exist in the Punjab, to judge from the story by Rudyard Kipling which had been told them about the Punjab. Mr. Vyasa Rao had mentioned some interesting superstitions that were not referred to in the paper. As a matter of fact he (the author) started his paper by saying that it would be impossible to read an exhaustive paper on Indian superstitions, because to do so would take a very much longer time than was at his disposal. He presumed that Mr. Gupta had spoken in a joking mood, but he assured that gentleman that he wrote the paper in anything but a critical frame of mind. It would be absolutely absurd for any Briton to criticise Hindus about their superstitions, for the simple reason that Britons were probably sunk quite as deeply in superstitions as the Hindus were. It was only necessary to remember the superstitions about fairies in Ireland, pixies in Devonshire, and brownies in Scotland, for it to be manifest that superstitions were quite as deeply rooted in Britain as they were in India, and to his own mind they were certainly not more picturesque.

* In this connection there is an interesting correspondence under the heading:—"Sir Charles Crosthwaite on India" in the *Times* of the 4th, 6th, and 7th October last.

ELEVENTH ORDINARY MEETING.

Wednesday, February 22nd, 1911; Alan S. Cole, C.B., in the chair.

The following candidates were proposed for election as members of the Society:—

Brichett, Dr. J. G., Cardwell, Missouri, U.S.A.

Bruch, Walter W., 64, High Holborn, W.C.

Converse, Edmund Cogswell, Conyers Manor, Greenwich, Connecticut, U.S.A., and 72, Broad-street, New York City, U.S.A.

Down, St. Vincent Bowen, Winchester House, Singapore, Straits Settlements.

Gladwell, Arthur, Brynmaur, Gerrards Cross, Bucks.

Harvey, Ernest William, F.C.S., The British Empire Club, 12, St. James's-square, S.W.

Hastings, Percy, The Cottage, Wimbledon-common, S.W.

Moitry, Manmatha Nath, Serampore, Hoogli District, Bengal, India.

Williams, Stacy B., Brockweir, Urmston, near Manchester.

The following candidates were balloted for and duly elected members of the Society:—

Crook, Thomas Mewburn, R.B.A., 10, Gainsborough-road, Bedford Park, W.

Genge, Henry Arthur Pope, Ootacamund, Madras, India.

Green, Richard Crafton, Newport, Essex.

Grundy, Cuthbert Cartwright, R.I., R.C.A., Home-field, Blackpool, Lancashire.

Gummá y Marti, Alfredo, Calle Universidad 30, Barcelona, Spain.

Heys, John, Heysham, Marine Approach, South Shields.

Lawrance, Dilipa John Skillern, 16, Infantry-road, Bangalore, India.

Lawrance, John C. Skillern, B.A., LL.B., Kirkton, 16, Infantry-road, Bangalore, India.

Lloyd, William, 29, Bridge-street, Staines.

Pott, Miss Constance M., 81, Cornwall-gardens, S.W.

Smith, Alexander Monro, 2, Denton-road, East Twickenham.

The paper read was—

EXPERIMENTS WITH "WATER-FINDERS."

By Professor J. Wertheimer, B.Sc., B.A., F.I.C., F.C.S.,

Principal of the Merchant Venturers' Technical College and Dean of the Faculty of Engineering in the University of Bristol.

In the Cantor Lecture on "Mine Surveying," in 1892, Mr. Brough placed before this Society a brief sketch of the history of the use of the divining-rod, more particularly for the purpose of finding metal. There are now, and have been

for many centuries, hundreds of people who believe firmly that, by the use of the rod, certain persons are able to find not only metals but also water, coal, and, as a recent wielder of the rod (Mr. Edwards, the sexton at Rodney Stoke) alleges—corpses! The rod has also been used quite recently to track persons, and at one time was largely in use for the purpose of finding criminals.

There is abundance of well-authenticated evidence that "Dowsers" or "Jowsers," as waterfinders are termed in the West of England, have repeatedly indicated spots where good supplies of water have been found. The object of my experiments was to ascertain whether or not these indications were caused by any influence outside the "Dowser," or whether he unconsciously gave indications not caused by anything external to himself. An attempt was made to induce all the well-known waterfinders to take part in the experiments, and the conditions were arranged beforehand, so that the powers of the waterfinders might be tested in a way that appeared to them to be fair.

Many of the professional "dowsers" declined any test except the very expensive and quite inconclusive one of "finding" water by means of the rod, etc., and then sinking wells to ascertain the accuracy of these indications. In such a "test" one cannot, of course, eliminate the possibility that in many parts of the country, especially those in which waterfinding flourishes, it is rather more likely than not that water will be found in any place chosen by a man having a knowledge of the conditions under which water is usually found. Moreover, if a well be sunk and no water is found at a certain depth, the waterfinder can always state that this is due to the well not being deep enough.

The methods of "dowsers" vary considerably; some use a twig, others a watch-spring, while one of the best with whom I experimented required neither twig nor spring. The conditions which they regard as essential also vary to a remarkable extent; some can find water only through the earth, others find a stone floor or a piece of linoleum no hindrance. Some can detect water in movement only; some allege that the presence of iron or coal is a hindrance; some can find running water in an iron pipe; others state this is impossible. This makes experiments with "dowsers" exceptionally difficult, since the conditions acceptable to one may be applicable to him only.

The experiments I am about to describe deal mainly with the finding of water, but some of them were directed to ascertain the value of the claims of certain "dowsers" to find gold or silver, while one experiment had in view a test as to the accuracy of the "dowser's" opinion that the external influence which caused the motion of his rod was electrical in character.

(A) Experiments to Find Water.

I. *At Brislington Hall.*

In the kitchen of this house there is a deep well with a constant supply of water, situated near the fireplace approximately at W, as shown on the plan, Fig. 1, which is roughly to scale. Three "dowsers" were, by kind permission of Mr. A. C. Ireland, J.P., taken to the Hall and asked to discover the position of this well by means of their rods. One of these—Mr. Chennels—indicated three spots in the kitchen marked respectively, C_1, C_2 and C_3, but failed to give any indication when over the well itself; but when told where the well was, he discovered the

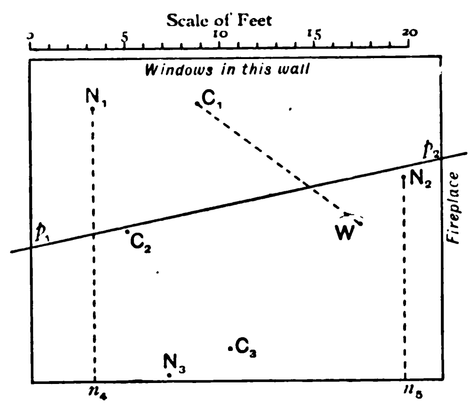

Fig. 1.

existence of a course of water running from C_1 to the well.

Another—the Rev. W. F. Newman, M.A.—got indications at three points, N_1, N_2 and N_3, and likewise traced two lines, N_1,n_4, and N_2,n_5, along which he supposed that there were underground streams of water. The third waterfinder—Mr. R. Pavey—drew a number of lines indicating the underground channels which he found, and one of these—p_1,p_2—like Mr. Newman's line N_2,n_5, passed close enough to the well to be regarded as a success, but, as will readily be seen, the indications of these three experienced "dowsers" are absolutely at variance with one another; if they are all correct, Mr. Ireland's property would be a very valuable investment for a water company.

II. *Experiments at Teddesley, Penkridge, Staffordshire.*

These experiments were performed by Mr. G. Roberts over a tiled drain in Lord Hatherton's Park at Teddesley. This drain is a few feet below the surface, and at the time of the experiments there was an abundant flow of water through it. The object of the experiments was to ascertain whether or not Mr. Roberts's rod moved invariably when passing over an underground stream of water. Mr. Roberts passed

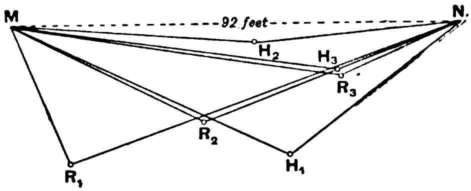

FIG. 2.

over the drain six times in all, three times his rod gave indications, but on the remaining three occasions the rod did not act when Mr. Roberts was on or near the drain; this proved that Mr. Roberts's rod does not turn with any certainty when over running water.

The rod indicated in a large number of places; certain spots where a number of indications were obtained within two comparatively small areas were carefully marked by stakes, their positions accurately measured and an amateur waterfinder—Sir Richard Harrington—who did not witness the experiments performed by Mr. Roberts, was subsequently taken to the two parts of the park in question, and was asked to re-discover the points indicated by Mr. Roberts. The results are plotted for one part on Fig. 2: R_1, R_2, and R_3 are the points indicated by Mr. Roberts; H_1, H_2 and H_3 are the positions selected by Sir Richard Harrington. In this case it will be seen that there is only one position in which there is an approximate agreement.

In regard to these experiments it is, however, right to say that, while Mr. Roberts was allowed ample time for his indications, Sir Richard Harrington had to make his tests speedily.

III. *Experiments in the Grounds of Downside Abbey.*

These experiments were performed by Mr. Rowland Pavey, who pictured to himself the hollows in the ground which contained water, and traced lines on the surface representing them. It was a condition of the experiment that lines traced elsewhere than where the known wells were situated were not to count, and Mr. Pavey was successful in finding the wells, as will be seen from Fig. 3; but Mr. Pavey drew so many lines, most of them curved, that it seemed to me probable that anyone drawing a similar number of lines at random would have drawn at least one which would pass through the well or spring to be detected. In stating this, I wish it to be under-

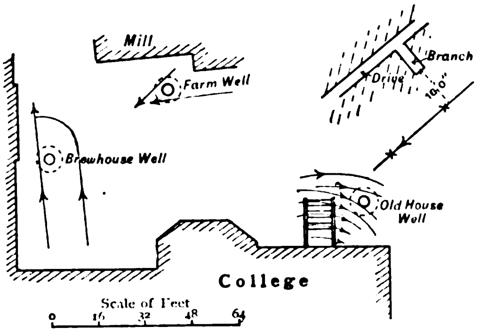

FIG. 3.

stood that I am perfectly satisfied that Mr. Pavey, whom I believe to be an honourable man, did not draw the lines in the way mentioned with any intention to make success certain in this way; on the contrary, I feel sure that he really believes in his possession of the powers he claims, and that the channels he traces have an actual existence.

IV. *Experiments in West Town Lane, Brislington, near Bristol.*

I put before Mr. Pavey my reasons for undervaluing the success he had obtained, and asked him whether his rod would indicate the presence of flowing water in an iron pipe. His reply was in the affirmative, and in the following experiments he was asked to stand over a water-main buried in the earth through which a large quantity of water was flowing. By the kindness of the chief engineer of the Bristol Waterworks (Mr. J. A. McPherson, B.Sc.) arrangements were made by which, at times unknown to Mr. Pavey, the flow of water was stopped, and Mr. Pavey was asked to ascertain when the water ceased to flow and when it began to flow again.

As shown on the accompanying plan, Fig. 4, a three-inch water-main passes through the lane in question; it is controlled by the three-inch sluice valve, shown on the plan, at the West Town end of the lane. The sluice valve was kept open the whole time, thus ensuring that the main was full of water, while the hydrant was opened and closed at fixed times. About five seconds were required to open and close

the hydrant; when the hydrant was opened there was a rapid flow of water through the three-inch main, while when it was closed the water was still. Mr. Pavey had stated that he was not affected by still water, but was affected by running water, whether contained in iron pipes or not.

In order to ensure perfect accuracy of working, a man was stationed at the sluice valve to see that it remained open during the whole time of the experiments; he was accompanied by a student of the Merchant Venturers' Technical College as a witness. The man whose duty it was to open and close the hydrant, was supervised by a foreman of the Bristol Waterworks and another student of the College; Mr. Pavey's observations were timed by Mr. McPherson and myself. Before commencing the experiments the watches used by the foreman, the student

Times when the water was turned on and off respectively at the hydrant.	Times when Mr. Pavey stated that, in his opinion, the water had been turned on and off respectively.
Off 3.15	On 3.15
	Off 3.15¼
On 3.20	On 3.23¼
Off 3.24	Off 3.24
	On 3.26¼
	Off 3.27
	On 3.28½
	Off 3.29
On 3.30	On 3.31
	Off 3.31¼
	On 3.32
	Off 3.33½
	On 3.35¼
	Off 3.35½
Off 3.36	

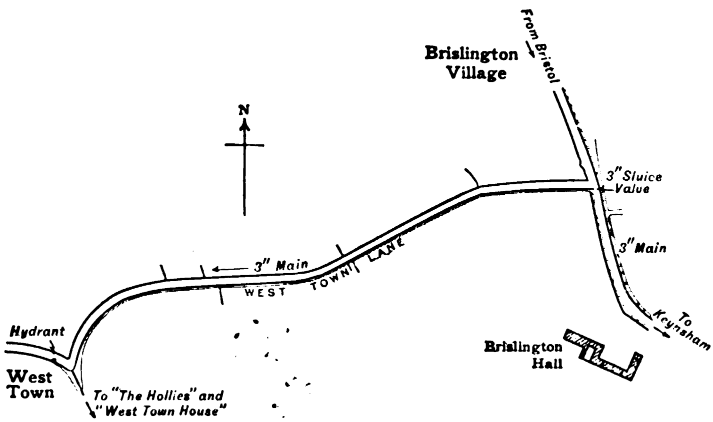

FIG. 4.

who accompanied him, Mr. McPherson and myself were all set accurately to the same time; at the end of the experiments they were again compared and found to be still in perfect agreement. The results of the experiments are shown in the accompanying table:—

Times when the water was turned on and off respectively at the hydrant.	Times when Mr. Pavey stated that, in his opinion, the water had been turned on and off respectively.
Off 3. 4	On 3. 6½
	Off 3. 7¼
On 3. 8	On 3. 9
	Off 3. 9½
	On 3.10½
	Off 3.11½
	On 3.12
	Off 3.12¾
	On 3.14
	Off 3.14½

At 3.35½ the experiments were suspended for a few minutes in order that Mr. Pavey might see to what extent his indications agreed with what had really happened; they were resumed shortly before 3.43.

On 3.40	On 3.43
	Off 3.43¾
Off 3.45	On 3.45¼
	Off 3.46
	On 3.47¼
On 4. 0	

Mr. Pavey was of opinion that his failure was due to the fact that the water engineer and myself were near him, and that we had prevented his success. He, therefore, offered to undertake another series of tests, and backed up this offer by undertaking to subscribe £5 to the Bristol Hospital if he failed once out of ten times in stating correctly when the water was flowing

through the main or when it was not doing so; it was also a condition that if he succeeded I should pay the hospital £10.

The experiments were completed under the precise conditions required by Mr. Pavey, and the result of them is shown in the accompanying table:—

Times when the water was turned on and off at the hydrant.	Times according to Mr. Pavey's time chart when, in his opinion, the water had been turned on and off respectively.
Off 2.42 On 2.46	
Off 2.55	On 2.56 Off 3. 0
On 3. 1	Off 3. 3
Off 3. 8	On 3. 9 Off 3.14
On 3.15	Off 3.15
Off 3.20	On 3.20 Off 3.27
On 3.30 Off 3.33	On 3.34
On 3.37	Off 3.40

Mr. Pavey paid £5 to the Bristol Hospital, and has since published a book criticising the experiments from his point of view. It contains a number of statements of a mystic character, such as his claim to be able, by means of his "pantoscopic" faculty, to see the wings which he alleges human beings possess, and also to see the electric fluid passing through their bodies. He assumes, quite wrongly, that his failures are due to some telepathic action which I have exerted upon him. Not only can I lay no claim to the wonderful power which he attributes to me, but also I had no desire that he should fail. On the contrary, I should have been delighted if he had succeeded, as I should then have had a most interesting field for research in regard to an hitherto unknown force, the existence of which would have been proved.

(*B*) Experiments to Find Gold and Silver.

I. *Experiments with Mr. Chennels.*

When at Brislington Hall, Mr. Chennels was asked first to choose a piece of ground where his rod did not indicate the presence of water. Twelve saucers were then arranged on this ground and sums of money were placed under some of these, viz., either £3 in gold or at least 7*s.* in silver. In the first trial Mr. Chennels indicated over five saucers; under two of these only was there any money. But there was money under three of the saucers over which Mr. Chennels's rod did not indicate, so that Mr. Chennels was right in seven cases and wrong in five.

In the second test only seven saucers were used; Mr. Chennels's rod indicated over six of these; these indications being correct in three instances and wrong in the remaining three. Under the seventh saucer there was no money, so that in this instance Mr. Chennels was right in four cases and wrong in three.

Subsequently, he performed experiments in the Great Hall of the Merchant Venturers' Technical College; he was asked to make certain that the places where the nine saucers used were placed were ones in which nothing would interfere with the success of the experiment. Accordingly, he placed the saucers himself on the ground, and then did a blank test with each saucer, thus making certain that when no coins were under the saucers his rod did not move. The sum of 10*s.* in silver was then placed under each of four of the saucers; Mr. Chennels indicated over four saucers under three of which there was money. Since there was money under only one of the remaining five saucers, Mr. Chennels was right in seven out of nine cases. This experiment must, therefore, be regarded as a success.

Mr. Chennels thought that he could do better in the open, and the next experiment was therefore performed in an open space at the back of the College. The same precautions were taken as in the previous experiments, each saucer being placed by Mr. Chennels and a blank test being made with the rod, when Mr. Chennels obtained no indications over any of the twelve saucers used.

Mr. Chennels's rod subsequently indicated over each of the twelve saucers, but money had been placed under only two of them, so that in this instance there were ten failures against two successes. Mr. Chennels endeavoured to explain his failure by stating that in his opinion there was either a mass of water under the ground in question or a bed of coal at a depth, as he estimated, of 1,000 feet. He also found the existence of water or coal in a covered space under the Great Hall where, strangely enough, he had performed the successful experiment mentioned above.

After Mr. Chennels had discovered the alleged bed of coal at the College, he said he would

prefer to try an experiment elsewhere. He was, therefore, taken to the garden of the Merchants' Hall, where he placed five saucers in positions selected by himself, and again made a blank test with his rod, ascertaining that it did not act over any of the saucers. At his request, money was placed this time only under one saucer.

Mr. Chennels discovered this saucer by means of his rod, but when asked to repeat the experiment, was unfortunately too tired to proceed.

It will be noted that in the five experiments with coins described above, Mr. Chennels obtained a large measure of success in two cases only.

II. *Experiments with the Rev. W. F. Newman, M.A.*

Eight cushions were placed on the floor of the dining-room at Brislington Hall; two sovereigns were placed under each of two of these cushions. Mr. Newman was then invited to find under which of the cushions gold was placed. In two cases he said there was gold under the cushions when this was not so; in a third instance he said there might be gold under the cushion, but was not certain. This was one of the cushions under which gold had been placed. He said there was no gold under the remaining five cushions, but there were two sovereigns under one of them. It will be seen from these results that the indications given by the rod were inaccurate. As Mr. Newman had previously obtained no indications with his rod over the places where the cushions were placed, it is, in my opinion, fairly certain that the vigorous movements of the rod which resulted in this test were due to subjective causes.

(*C*) Experiment to Ascertain if the Motion of a Dowser's Rod is Due to an Electrical Cause.

In the course of our correspondence, Mr. Newman expressed the opinion, frequently held by dowsers, that the action of his twig was due to some electrical cause, and that, if he was insulated from the ground, his rod would not act. I told Mr. Newman that experiments in this direction had already been performed, and that the results justified the belief that the motion of the rod was not due to such a cause. It was, however, decided to try the experiment, and Mr. Newman accordingly proceeded to choose a spot outside Brislington Hall where his twig gave strong indications; Mr. Newman was then asked to stand upon a stool carefully insulated, but so arranged that it could be connected to the earth without Mr. Newman knowing when this happened. Mr. Newman thought that the indications of the twig were not quite as vigorous when he was insulated, but he admitted that the difference, if any, between the indications given when he was and was not insulated respectively was so slight that it was useless for him to try to say when insulation took place or not—in fact, the result was that he was satisfied that the motion of the twig was not due to an electrical cause.

Conclusion.

Since these experiments were undertaken, I have received a large amount of correspondence and many publications in regard to dowsing in this country and abroad, but I have not been able to find any experienced dowser willing to submit to definite experiments, nor have I been able to induce the proprietors or agents for any of the instruments for finding water to submit these to a scientific test.

My opinion is that the motion of the dowser's rod and the sensations which he experiences are not due to any cause outside himself. On the other hand, I believe that when the dowsers with whom I experimented stated that they did not cause the rod to move, they were saying what they believed to be the truth, but were unconsciously misleading themselves.

DISCUSSION.

The Secretary read the following communication from Professor W. F. Barrett, F.R.S.:—I am glad that th3 subject of "Waterfinders" has been brought before the Royal Society of Arts, and regret my distance from London prevents my attendance. Having given to this subject many years of careful investigation, perhaps I may be allowed to make a few remarks. When a paper is read before a learned society on an obscure and controverted question, it is usual for the author to make himself acquainted with the history of the subject and acknowledge—even if he does not discuss—the investigations and conclusions of those who have previously explored the same field; provided their scientific standing and the precautions they have taken justify such an acknowledgment. Professor Wertheimer, however, has not thought fit to take this course, for what reason I do not know.

The author tells us that the object of his experiments was to ascertain whether the indications given by the dowser were due to an influence outside the dowser, or were purely subjective, and he arrives at the conclusion that "the motion of the dowser's rod and the sensations which he experiences are not due to any cause outside himself." This conclusion is based upon a few experiments with two professional dowsers, Chennels and

Pavey, and two amateur dowsers, the late Sir R. Harrington and the Rev. W. Newman, together with a dowser, Mr. Roberts, who is not further described.

The principal experiments were with Pavey and Chennels, and consisted of tests on still or running pipe-water and finding hidden coins. Whether such tests are of value in ascertaining the claims of dowsers to be waterfinders is a matter of doubt. Some years ago I requested Mr. E. Westlake, F.G.S., to conduct a series of experiments with Pavey and three other Somersetshire dowsers, to see whether their respective and independent indications of underground metallic lodes coincided or not. The results are given in an appendix to my last Report on Dowsing and published in the Proceedings of the Society for Psychical Research for 1900. It turned out that Pavey was only right about once in six, whereas another dowser, Day, was right in one half the trials. But the general result was inconclusive and of no evidential value.

The test of running pipe-water selected by Professor Wertheimer is not a desirable one. In the first place it is difficult to prevent some slight sensory indications arising from the sudden stoppage and reflow of the water, and in the next place the experiment has little bearing upon the main object of the inquiry.

Of the other professional dowser tested by Professor Wertheimer—a man named Chennels—I know nothing; I think were he a dowser of any repute I should certainly have heard of him. There are of course many persons who—finding a forked twig suddenly twist in their hands at certain spots—believe they have a peculiar gift of ore or water-finding, but are self-deceived. The unconscious and involuntary muscular action which causes the dowsing-rod to turn, is by no means uncommon, and is a familiar illustration of what is known as "motor automatism."

The qualifications of anyone who professes to be a dowser need to be tested, and his record critically examined, before wasting time in using him as the subject of serious scientific investigation. In this respect Professor Wertheimer has been singularly unfortunate, and whilst I welcome the interest he has shown in the subject, I do not think he has much advanced our knowledge in one of the most difficult regions of psycho-physical inquiry.

It is now some twenty years ago that, at the request of the late Professor Sidgwick and the Council of the Society for Psychical Research, I reluctantly consented to undertake an investigation into this subject. On *a priori* grounds it seemed to me far more probable that any success the dowser achieved was due either to the prevalence of water-bearing strata, a shrewd eye for the ground, or chance coincidence—than to any peculiar gifts he possessed. Moreover, it is well known how frequently failures are forgotten and lucky hits are remembered. Hence I was quite unprepared to find a remarkable body of evidence in favour of certain dowsers, notably the late John Mullins, and, after five years laborious investigation, I was driven to abandon the explanations I have just given as inadequate to cover *the whole ground*, though they are true enough in certain special cases. After publishing my first lengthy report, further investigations were made, with the aid of able and critical geological advice, and these were published in my second Report in 1900. Since then a bulky mass of additional evidence has accumulated, and will be published shortly. It is obvious I cannot give even the briefest outline of this evidence at the present moment. It is sufficient to say that if Professor Wertheimer, or anyone else, can give a more satisfactory explanation of this evidence than I have ventured to make, I shall heartily welcome it.

My own conclusions are that the involuntary motion of the rod, or the *malaise* which occurs in certain dowsers on approaching the hidden object of their search (whatever that object may be), arise from an obscure nervous reflex and muscular spasm, which is stimulated by suggestion and also by other causes. Among the latter, in a good dowser, may be classed a transcendental perceptive power, not consciously exercised, but able to start a nervous or muscular spasm. Evidence of the existence in certain individuals of such a faculty new to science, goes back to a remote period, and is supported by a considerable amount of trustworthy and recent experimental research, so that its recognition by science may be hoped for in the not distant future. This faculty is one allied to that of *instinct* in animals, inasmuch as it is a case of *nascitur non fit*. Further experiments in dowsing—conducted with the same care as Professor Wertheimer has taken—are greatly to be desired, but it is hopeless to expect any conclusive results without prolonged investigation. Negative evidence in psychical research is of the same value as the negative evidence adduced by those who deny the existence of meteorites because they have never seen one fall.

P.S.—The word "dowsing-rod," I may say, in answer to inquiries, is probably the Celtic-Cornish translation of striking-rod, the colloquial German name of the divining "rod," *duschan rhodl* becoming in time "deusing," and thence "dowsing-rod," and hence our modern "dowser."

Mr. T. W. Danby said that the divining practised by the earliest dowsers was for minerals, whereas the object of the modern dowsers was to find water. Agricola, the well-known authority on mediæval mining, stated that the use of the divining-rod enabled the dowser to find only mineral veins, which was very different from finding pockets of water or ore, or springs of water. A mineral vein had this mysterious characteristic, that there was no record in any mining book of any observer ever having got to the bottom of a mineral vein. Fifty years ago, when he was a student at the Royal School of Mines, he had the

only personal experience in his life of dowsing, and he was very much astonished at the results. During the long vacation he and a fellow-student had the privilege of travelling with the then Professor of Mining, the late Sir Warington Smythe. First of all, they went into North Wales, where, to his astonishment, he found that the miners believed thoroughly in divining. From Wales they went to the Isle of Man, where he was still more astonished to find that dowsing was a positive article of belief. In discussing the subject with some of the mining captains, the suggestion was made that, as his fellow-student and himself knew nothing of the locality, and were profoundly sceptical on the subject, the opportunity should be taken of putting dowsing to a practical test. It was thereupon agreed that his fellow-student and himself should walk along holding a hazel twig, the point of which was upwards, near the old Foxdale silver mines; that a miner should walk by the side of them, and when the divining-rod turned down, the miner should mark the place with his pick. He walked along with the twig, and, to his blank astonishment, it turned down more than once, while his fellow-student's twig also turned down at intervals. The captain of the mine subsequently said that he did not think his fellow-student had been very successful, but his (Mr. Danby's) indications were nearly all correct—in fact that he was an expert diviner!

Mr. S. Simmelkjoer stated that during the meeting of the German Association of Gas and Water Engineers, held in Königsberg in June, 1910, Mr. Bieske read a paper upon the divining-rod, and at the conclusion of an interesting discussion the author made the following remarks: "During the discussion the word 'swindle' has been used several times. I did not use that word, and I do not approve of it, because, in my opinion, in most cases it is more a question of disease than of swindle." That remark was heartily approved by the meeting.

Mr. W. N. Gardner asked whether the author knew of any case where a water diviner had been able to state the quantity of water which would flow from a particular source.

Mr. C. H. J. Clayton inquired whether Professor Wertheimer had any experience of dowsers on clay lands where it was practically impossible to find water.

Professor Wertheimer, in reply, said he did not know of any case where a dowser had been able correctly to determine the quantity of water which was to be derived from the source he had discovered, but there were two machines on the market which professed not only to find where water was present, but also the depth at which it existed. He had written to the persons interested in those machines asking them to perform some tests with them, but so far, for various reasons, they had not found it possible to do so. He had not tried any experiments on clay lands, as he had not deliberately asked a dowser to conduct an experiment that was certain of failure. He had always taken the dowser to a place where there was water for him to discover, so that he might work under the fairest possible conditions. He did not intend to start any technical training for dowsers, although he regretted to say there were, in the West of England, certain gentlemen who took apprentices and professed to teach them the art and mystery of dowsing. With regard to Professor Barrett's criticisms, he did not give the history of the subject in his paper, mainly for the reason that Professor Barrett had given it so very fully himself, his papers covering two whole parts of the Proceedings of the Psychical Research Society. Those papers gave a vast amount of evidence, very little of which, however, was of an experimental character. The kind of evidence given by Professor Barrett was that Mrs. So-and-So stated she knew that a dowser did indicate that water would be found in a certain place, and on a well being sunk water was found there. Personally, he was not concerned in that class of evidence, because he admitted at once that many cases of that sort were undoubted facts. Professor Barrett next stated that the test with running water was an unfair one. He had not taken upon himself to say what was fair and what was unfair; he had gone to dowsers and asked them to lay down what they considered a fair test, and this, it seemed to him, was the scientific way to attack the question. It would be very unfair of him, if a chemist told him that he could do something wonderful in chemistry, to ask the chemist to prove it to him by conducting an experiment in accordance with conditions that he (the author) would lay down. That would not be at all fair; the chemist must be allowed to conduct his experiment in his own way. Therefore, when Mr. Pavey told him that he could discover water in an iron water-pipe, he did not ask himself whether Professor Barrett thought it was fair or not, because Mr. Pavey himself thought it was fair and carried out the test. Then Professor Barrett thought that sufficient care had not been taken to secure the real article to carry out the tests. That was absolutely wrong. Mr. George Roberts, one of the gentlemen of whom Professor Barrett had never heard, was vouched for by no less than six gentlemen of good position in his own neighbourhood; he had worked for a great number of people, and was exceedingly well-known; in fact, there was no doubt he was a professional dowser of considerable ability.

On the motion of the Chairman a vote of thanks was accorded to Professor Wertheimer for his paper, and the meeting then terminated.

HOME INDUSTRIES.

Plague and the Silk Trade.—It seems that the plague has obtained a footing in Chefoo, one of the chief Chinese silk centres. The silks collected there are despatched to Shanghai, either direct or *via* Tsingtan, and thence distributed by the European houses to consumers in America, Europe, India, and Asia Minor. The principal varieties are Shangtung tussore, and Shangtung pongees. It is said that the Chinese silk export trade is being seriously affected by the disorganisation and reduction of transit facilities resulting from the precautions taken to prevent the spread of the plague, and there is considerable delay in the arrival of silk at the ports. It is expected that the next silk crop will show a large decrease.

Sudanese Cotton and the Trade Outlook.—It is reported that several cotton merchants in the Sudan intend to forward all their cotton direct to Liverpool, and already one shipment has been so sent through the Kordofan Commercial Company. The reports as to the present crop are very encouraging. The Economic Board of the Sudan Government gives the following details on the state of the crop:—"In November 35,000 feddans were reported to be under cotton at Tokar. Rains have been good, and a satisfactory crop may be expected. The quality should be even better than last year, as all seed sown has been good Egyptian of one kind. The plants are in the best possible condition. The greater part of the crop is from Mitafifi seed provided by the Government on repayment. Cotton in Berber province, according to reports for November and December, is not coming on so well. Natives are inclined to starve their cotton as regards water. Egyptian cotton was successfully grown as a flood crop in the White Nile province. This is noteworthy, as vast areas of flood land are available in that province. Lack of rain spoilt the cotton at Renk. Cotton as a rain crop is reported fair at Kodok and Melut. Picking was to begin in December. As a general rule, cotton is poor when sown on untilled low ground where rain streams have washed over it, but at Malakal a crop sown very late proved an exception to this. A good crop is expected from Debeloweid." Commenting on the cotton trade outlook, Mr. F. Ashworth, writing to the Manchester Chamber of Commerce, asks:—"Can the consuming world take off a full production at the present comparative high cost?" In his opinion, with the present capacity of production, and given sufficient inducement, it would be quite possible to supply for export from this country, 600 million yards per month (the monthly average in 1910 was 500 million yards) of assorted cotton piece goods (or 7,200 million yards per annum). But our oversea markets are not yet capable of taking up such a supply, even at normal prices, still less at present rates. Mr. Ashworth's conclusion, therefore, is that the preservation of healthy relations between supply and demand does not admit of the machinery, either spindles or looms, being continuously worked at its full capacity throughout the current year, under the prospective conditions governing the trade. There is still too much machinery for the capacity of the markets.

The Growth of Insurance.—The returns just published by the Board of Trade relating to life assurance testify to the continued development in all branches of life assurance. The total amount of life assurance effected with British companies during 1910 exceeded the total recorded for any previous year. As showing the growth in the amounts paid in premiums in connection with ordinary and industrial schemes of assurance, and the increase of funds, the following figures are given:—

	Ordinary Assurance. Premiums.	Ordinary Assurance. Funds.	Industrial Assurance. Premiums.	Industrial Assurance. Funds.
	£	£	£	£
1890...	13,928,001	160,172,605	4,360,438	7,167,869
1895...	16,862,514	188,372,536	5,927,835	11,875,423
1900...	20,829,017	231,339,585	8,078,728	18,392,283
1905...	23,903,788	277,537,214	10,600,611	27,111,038
1909...	29,402,259	336,413,395	14,127,016	42,669,066

The assurances in force at the end of 1909 aggregated £782,198,531 under ordinary tables, in addition to £292,689,157 industrial policies. In 1890 the figures respectively were, £442,436,266 and £85,920,639. The growth in industrial business has been very rapid during the period under review, and the figures point to the growing prosperity of a large section of the community. They also refute the prophecies of those who held that legislation would prove injurious to life assurance business.

The Motor Liner.—Reference was recently made in these Notes to the order in the hands of a Clyde firm for an oil-engined Atlantic liner, but particulars were wanting. It is now known that she will be of 5,000 tons and will carry both passengers and cargo. This is the first serious attempt of British shipbuilders to construct a motor-boat of such large dimensions. A cargo motor-boat of 8,000 tons is being built in a German yard for the Hamburg-America line, and will, it is expected, be ready for service early this year.

Educated Women Workers.—The report of the work done in the first eighteen months of its existence by the Educated Women Workers' Home Training Fund is encouraging. During the period named fifteen women have finished their training, two have entirely paid back their fees, and seven are paying regular instalments. The professions adopted include midwifery, physical culture, lecturers, and teachers of dancing. The Association lends money to girls and women who desire the training necessary for a specified profession, and the question of funds is therefore all important. Much more money is wanted if the Fund is to do all it might do in the way of help to poor gentlewomen, and it ought not to be very difficult to get it, provided the organisation is on a sound business basis.

Piece Goods for Southern Nigeria.—Attention is called to a proposed amendment of the Folded Woven Goods Ordinance of Southern Nigeria by a Bill about to be introduced into the Legislative Council. The Bill permits some variations in the manner of folding certain goods to meet the requirements of the trade, and consolidates the various amendments already made to the original Ordinance. The following new section is quoted:—

No folded goods other than those specified in the schedule thereto shall be imported into the colony or protectorate unless the same shall be folded in folds not less than 36 inches in length and each piece be marked with the number of yards and inches (if any) contained therein. Such mark shall be stamped on the fabric of each piece. Any words, figures, marks, or abbreviations of the words "yards" and "inches" which, according to the common use or custom of the trade are commonly taken to indicate the measure of the folded woven goods, may be used in such marking. No piece shall be made up to show more folds than the full number of yards it actually contains, any portion of a yard (over such number of yards) not to be shown as a fold. The above section is to apply to all folded woven goods imported into the colony or protectorate, whether for sale, use, or disposal therein, or for transhipment to or in transit for any other country, port, or place, but the Comptroller of Customs may, with the approval of the Governor, exempt goods in transit for any other country in which the manner of folding or marking such goods is regulated by law.

The exemptions referred to are those given in the *Board of Trade Journal* on December 1st, 1910.

The Manchester Canal.—Messrs. W. H. Coward, Limited, of Finsbury Pavement, have addressed a letter to the Manchester Ship Canal Company advocating the provision by shipowners of more accommodation for dead-weight cargo in the steamers that already load in the Canal. They write:—

"We take the liberty of addressing you on the subject of a great inconvenience, amounting practically to the negation of the advantage promised as a result of the extension of the sea traffic of Manchester, so far as shippers of dead-weight are concerned. We are considerable exporters to the British colonies of cast-iron pipes, machinery of all kinds, fire-bricks, and goods generally, all of which come under the denomination of dead-weight. We are also, in a smaller degree, shippers of measurement goods from your city. It appears that from the limited draught of steamships necessitated on leaving your port the tonnage offering is not sufficient to carry away the accumulation of cargo, and a large quantity is at present diverted, at an increased cost of carriage, to other ports. This state of things is sufficiently serious, but when we find, and we believe we are correct, that in most cases steamers ascending the Canal are already partly supplied with dead-weight collected at other ports, it produces circumstances absolutely adverse to the prosperity of Manchester as a loading centre. The remedy for this anomalous position naturally appears to be the increase of tonnage, and in order to make up satisfactory general cargoes a due proportion of measurement should also be forthcoming, which the brokers say they cannot obtain."

The letter will no doubt receive the attention of the Manchester Association of Importers and Exporters.

The National Telephone Position.—The report of the National Telephone Company for the first half of the current year has just been issued, and is the last report the Company will issue as a going concern. When it passes under the control of the Postmaster-General it will have been in existence for twenty-four years, and its revenue has now reached a sum approximating to three and a half millions sterling. The percentage of working expenses to net income has been steadily increasing in recent years, and is now over 64 per cent. as compared with 56·32 per cent. in 1896, but its net income is over one million. The Post Office takes over the undertaking on lines similar to those governing tramway transfers; that is to say the plant will be purchased at its fair market value, regard being had to its suitability for the purposes of the Post Office telephone service, but no payment will be made for goodwill or compulsory purchase, and certain powers of objecting to plant as unsuitable are reserved to the Postmaster-General. At the option of the Government, three-fourths of the purchase-money, and with the consent of the Company the whole of it, may be paid by way of annuity for a term not exceeding twenty years. That portion of the purchase-money not paid in cash will take the form of terminable annuities running over the period named, interest on the balance outstanding from time to time being fixed at the rate of 3 per cent. per annum, payable quarterly. The total amount of capital invested in the Company is £11,483,593.

CORRESPONDENCE.

THE TAJ MAHAL, AGRA.

The number of the *Journal* containing Mr. Robert Chisholm's paper on The Taj Mahal, etc., has just reached me in Egypt. I regret that where I am now I have not suitable books of reference at hand, but I should like to point out that the dimensions of some great domed buildings in Europe which Mr. Chisholm gives are far from correct. He tells us that Santa Sofia at Constantinople covers a square of about 130 feet. By this statement he must mean that the dome covers a square of that area. This is by no means the case. The span of the dome, which is the same as that of the square on which it rests is just about 100 feet. "St. Peter's at Rome, about 126 feet." This is not a remarkably clear statement. No doubt he refers to the span of that majestic dome which rests on a square with the corners cut off, and has a diameter of 140 feet or thereabout. "St. Paul's, London, 95 feet." St. Paul's dome covers a square space, although by the arrangement of the great supporting arches it might be supposed to stand over an octagon, and this space is 108 feet across.

SOMERS CLARKE.

Mahamid, Upper Egypt,
January 13th, 1911.

Mr. Robert F. Chisholm, to whom the foregoing letter has been submitted, writes in reply:—

Mr. Somers Clarke, in his note dated January 13th, calling into question my figures of the relative sizes of the areas covered by the well-known domical buildings, Santa Sophia, Constantinople; St. Peter's, Rome; and St. Paul's, London, does not seem to realise the impossibility of any two men agreeing as to how the relative merits of the structural difficulties overcome can be presented by measurement. Even the straightforward measurements are many. There is, first of all, the simple size measured from wall to wall at the floor level; secondly, the size measured in the same way at any point between the floor level and the level of the springing of the dome; thirdly, the length of the side of the greatest square which can be inscribed within the points of support parallel with the main axis of the building; fourthly, the side of the greatest square set diagonally with the main axis; and, fifthly, the diameter of the dome itself—whence arise other considerations. The Byzantine dome (Santa Sophia) resembles half an orange with the four cheeks cut off by vertical lines, leaving four points making a square which rest on the *centres* of the sides of, say, a square box, whereas in St. Peter's the half-orange rests on the *corners* of the box. In St. Paul's these corners are split up into three, so that the dome has twelve supporting props. Further, it is noted that every advance of the corners diminishes the difficulty of the structural problem, and that this cutting off of the corners is itself modified by its form and solidity. I think, as incidental statements having no reference whatever to the paper I was reading (The Taj Mahal), I will let them stand as they are. The main point is that whereas Mr. Somers Clarke places St. Peter's first as a structural achievement, I place Santa Sophia first; and I think the majority of the members of the architectural profession will agree with me.

LINEN AND COTTON UNDERWEAR.

As one of those persons who adopted linen underwear, with satisfactory results, on hearing a paper read on the Linen Industry in Ireland, last year, supported by a medical opinion recommending it, Sir G. Birdwood's remarks on page 359 of your proceedings of the 17th inst. come to me as a shock. It is claimed for linen that it absorbs moisture very rapidly, and dries very rapidly, allowing the skin to breathe, and prevents chills and colds; whereas cotton and wool absorb moisture slowly, dry very slowly, retaining the moisture of the body, become felted, choke the pores, and encourage chills and colds. I always understood that those who could afford it in the East used linen or silk underwear, while cotton was only adopted on account of its cheapness. Perhaps some of your readers can authoritatively determine this difference of opinion and the truth of the matter.

G. E. Jones.

BOOKBINDING.

With reference to Mr. Stephen's interesting paper, and the discussion thereon, I have two remarks to make, as a user of books. In the climate of Madras it is an ordinary thing for the dye to come off a book-cover on to one's hands and one's knees, however lightly it may be handled or rested. The chocolate colour of Chambers's "Mathematical Tables" comes off as a bright red. Books intended for engineers have to go to hot and damp places, a fact which should be borne in mind by publishers. The other point is that wall-crickets, and some other insects, are kept off by certain dyes. I had many books bound when in Madras, especially in two colours, a pink (the reverse side of a red) and a pale green (the reverse side of a dark green). In both cases the side I used shows the threads, and I much prefer it to the side intended to be used. The material, very cheap, is, I believe, cotton, and seems to be sized. If not placed in a shutting-up book-case the pink covers are attacked at once by the wall-crickets, which, slobbering as they feed, make pale patches of a blotchy character, sucking out the size, but not attacking the threads. The green covers, on the contrary, were never attacked even when placed amongst pink books on which the creatures were feeding.

Reginald Ryves.

NOTES ON BOOKS.

The Life-Boat and its Work. By Sir John Cameron Lamb, C.B., C.M.G. London: William Clowes & Sons, Ltd. 1*s.* net.

Readers of the *Journal* will no doubt remember that about a year ago Sir John Cameron Lamb read before the Society a paper, in which he gave a very valuable historical account of the origin and development of the life-boat from the date of its invention in the eighteenth century down to the present time. The subject is one with which Sir John is peculiarly well fitted to deal, as he has long been connected with the Royal National Life-Boat Institution, and is now its Deputy Chairman. As Chairman of the Council of the Royal Society of Arts, he was also much interested in the part played by the Society in the early development of the life-boat: and he relates how, in 1802, it awarded a gold medal and fifty guineas to Henry Greathead; in 1807 a gold medal to Christopher Wilson; in 1810 a silver medal and twenty guineas to the Rev. J. Bremner; in 1814 a silver medal and ten guineas to Thomas Boyce; and in 1817 a silver medal to Captain Gabriel Ray. These rewards were all granted for inventions in connection with life-boats, and if, as Sir John Lamb says, it is difficult to restrain a smile at the details of two of them, the fact of their award shows that the Society—true to its pioneer principles—was alive at a very early period to the importance of encouraging research in this direction.

It is, perhaps, hardly necessary to describe in detail the contents of the book, as they are the same in substance as the paper which appeared in the *Journal* of February 18th, 1910. A number of excellent illustrations have been added, not the least interesting of which is a reproduction of the wreck-chart of the British Isles for 1907–8—a most convincing argument for the cause which Sir John Lamb advocates. The little book gives an extremely interesting and complete account of the subject with which it deals, and it is to be hoped that it will enjoy a wide circulation, the more especially as any profits derived from its sale will be handed over to that most deserving of bodies, the Royal National Life-Boat Institution.

GENERAL NOTES.

International Art Congress at Rome.—Arrangements have been made to hold an International Art Congress in connection with the Exhibition of Fine Art which will be opened at Rome on March 27th next. The Congress will last for eight days. The subjects to be discussed have been divided into five groups: (1) Problems connected with culture and teaching; (2) the teaching of art; (3) æsthetics and public art; (4) exhibitions, competitions, legislation; (5) study and experiment in technical processes. A large and influential International Patronage Committee has been formed, under the presidency of the Minister of Public Instruction.

Indian Oyster Culture. — The American Consul at Calcutta states that an article on Indian oysters in the Madras Fisheries Bulletin has drawn attention to the commercial possibilities of oyster culture in India, for although there are numerous natural oyster-beds in various parts of India, there is no organised oyster industry anywhere. Some years ago the oyster-beds of Sindh were exceedingly prolific, and made Karachi famous. To-day the supply is totally insufficient, and the beds practically wrecked. In most of the estuaries of the Madras Presidency edible oysters are found. The shape of the Indian oyster seems to be determined by the character of its habitation. In muddy creeks and channels they are long and narrow, and in sandy beds of water they assume a broad form An ideal oyster-bed has been discovered in the Pulicat Lake, but the most extensive beds in Southern India are those in Cochin Harbour. Early precautionary measures should, it is said, be taken to safeguard all existing beds, and their cultivation developed by the introduction of experts.

The Silk Industry in Italy.—The importance of the Italian silk industry may be seen from the following figures taken from a Ministerial report recently issued.

The number of silk manufactories throughout the country are 2,413, employing a total of 232,549 hands, of whom 20,307 are males and 212,242 are females. Their wages amount annually to seventy-five million of lire (three million pounds sterling).

Amongst European nations, Italy still holds her position as the largest silk producer, but during the last twenty years she has lost the supremacy she then held, and now occupies only the third place, as will be seen from the following statistics:—

	1890–91.	1909–10.
China . .	4,910,000 kilos.	7,480,000 kilos.
Japan . .	2,018,000 „	8,672,000 „
Italy . .	4,590,000 „	4,251,000 „
France . .	650,000 „	674,000 „

The Egyptian Cotton Industry. — A recent Khedivial decree has authorised the creation of a Department of Agriculture in Egypt, and the appointment of a Director-General to that office. Although no definite plans have yet been formed as to the work of the new administration, it is believed that it will have to do principally with the control of cotton culture, and by systematic surveillance to prevent over-irrigation of the cotton fields by native growers, who in the past have retarded the maturity of the plants by flooding the fields too frequently. The education of the native farmer as to the proper kinds of seeds to use and as to the best crop rotations will, it is believed, also claim much of the attention of the new department. The Director-General is now visiting the cotton-producing districts with a view to gathering first-hand knowledge of the actual conditions that he will be called upon to supervise. The Egyptian Government is experimenting on its Korashieh Estates with a new cotton-seed styled "Assili," which has produced approximately 800 pounds per acre. It is like "Afifi" in colour, but better in quality, and is expected to fetch about eight shillings and fourpence more per hundredweight than any other variety cultivated in Egypt. The Ministry of Agriculture at Constantinople has asked the Ottoman High Commissioner in Cairo to send a quantity of Egyptian cotton-seed of the best varieties with a view to being tried in Turkey.

Chinese Pottery in the Straits Settlements.—Chinese are pioneers in the art of pottery. They use few implements, and the rapidity with which they fashion pots is marvellous, especially some of the Straits Settlements potters. The potter's wheel is the essential part of the workman's equipment. This is a large flat disc of stone revolving on a pivot. When the clay is properly prepared, a five-pound piece, which is sufficient for a ten-inch pot, is cut off, rolled into a ball, dabbed with burnt rice husks, and placed on the disc. The workman's left hand is gently thrust into the centre of the clay, while his right hand is slightly pressing on the outside to keep the whole together; but it is from the inside that most of the shaping is done. Meanwhile the wheel is made to turn more quickly. Then by keeping both hands

opposite each other—*i.e.*, one inside and one outside—together moving slowly up from the wheel, pressure by both hands is exerted, and the shapeless mass of clay assumes the shape of a pot with astonishing rapidity. A thin piece of wood is used to flatten the rim, and usually the same piece is used to measure the pot to see if it is the correct size. A potter will mould two ten-inch pots in three minutes. These newly-made pots are set in the sun for one day, and then placed in an oven arrangement, where they are "fired," an operation which takes four days.

Traffic on the Simplon Railway.—Since the opening of the Simplon Tunnel in the spring of 1906, both the passenger and goods traffic by this route show a marked increase, as will be seen by the following returns:—

	No. of Passengers.	Goods.
1906	260,000	26,000 tons.
1907	365,000	75,000 ,,
1908	375,000	81,000 ,,
1909	376,000	102,000 ,,
1910	497,000	135,000 ,,

The Production of Sparkling Burgundy in France.—In making sparkling Burgundy, the best qualities of wines are carefully selected and kept in cool cellars, to be prepared to the taste of its consumers. The fining and racking require the greatest attention. The wine is then bottled and piled in a cellar having a steady temperature of 50° Fahrenheit, where the fermentation takes place. The American Consular Agent at Dijon says that under normal conditions fermentation takes two years. When the ferment has destroyed the original substances, which prevented limpidity and good conservation, the carbonic acid gas, created by the decomposition of the natural sugar, produces the final and complete clarification, and the wine has received the maximum of its hygienic quality. When fermentation is finished, and the sediment precipitated, the bottles are placed on an inclined table, necks downward, and gently moved every day for sixty days, so as to bring the sediment to the corks. The corks are then removed, and the sediment forced out by the gas in the bottles. The operation must be carried out as quickly as possible to avoid loss of wine. The bottles, after being refilled and recorked with new corks, are put back in the cellar, and are ready for labelling and shipping.

Alcohol from the Carob Bean.—The discovery that alcohol can be extracted from the fruit of the carob tree has caused this article to be looked upon as much more valuable than formerly. This tree is a leguminous evergreen found in Spain, Italy, and the Levant, and its fruit, commonly called the carob bean, is about one inch wide and from six to eight inches long, and when dried has hitherto been used as food for animals. Experiments have lately been made in Spain to obtain alcohol from this bean. After triturating the fruit it was immediately placed in hot water to steep, and the sugar or glucose extracted by means of a current of water. The liquid resulting from this process was then allowed to ferment, the glucose thus being transformed into alcohol, which was later distilled. It was found that 2·3 quarts of pure alcohol could be obtained from twenty-two pounds of the beans. A factory has been established at Faro, in Portugal, furnished with a triturator of 4,000 pounds' capacity per hour. Here the practice is to steep the beans in four or five times their weight of water. The quantity of water depends upon the amount of glucose contained in the beans, which must be determined chemically. The distilling is carried on with the most modern apparatus, because the alcohol from the carob bean, unless very pure, emits a peculiar odour and has a disagreeable taste. Owing to the great quantity of carob trees (*algarrobo*) in Spain, this discovery will probably establish another important industry there, as well as in other Mediterranean countries. Large quantities of the bean are grown in the neighbourhood of Barcelona; and in the provinces of Valencia and Castellon, and in the south, the production is even greater.

United States Coal Production.—According to reports received by the United States Geological Survey from coal-mine owners and others familiar with the industry, the production of coal in the United States during 1910 was between 475 and 485 million short tons, a considerable increase over the output of 460 million short tons in 1909, and approximately within one per cent. of the maximum previous record of 480 million tons produced in 1907. Of the total production in 1910, the anthracite mines of Pennsylvania contributed nearly 83 million short tons, and the bituminous mines between 390 and 400 million tons.

Coco-nut Oil Butter in Austria.—A new substitute for butter has been placed on the market in Western Bohemia. It contains no animal fats, but is manufactured from coco-nut oil, the yolk of eggs, and a small proportion of cream. The coco-nuts are imported by the shipload by way of Hamburg, up the Elbe to Aussig, where the factory is situated. The meat of the coco-nuts is pressed for the oil, the outer fibrous shell is used in the manufacture of mats, and the hard shell is made into buttons. Coco-nut oil has been used for some time in Europe in the manufacture of oleomargarine under various names, but in combination with lard or other animal fats. The "vegetable" butter is prepared in two forms—soft and in firm cakes. It is shipped by parcels post from the factory in packages of five kilogrammes (eleven pounds). The claim is made that this butter substitute has an agreeable flavour, is not injurious to health, and is excellent for cooking purposes.

The Mangrove Bark Industry in Australia.—A company has been formed in Sydney for utilising mangrove bark to meet commercial

demands for tanning and dyeing purposes, and, according to the American Vice-Consul in that city, a concession has been obtained from the Government of Queensland for taking the bark from trees on land near the coast of North Queensland, between Cooktown and Cape York. It is said that the supplies of black mangrove trees in the northern part of Australia are almost unlimited, the forests being found along rivers, creeks, and estuaries near the coast, frequently on mud flats, which are inundated at high tides. Many of the trees grow large, and permit of poles fifty feet long being cut, while from a single tree upwards of a ton of bark has been stripped. Previous attempts to make commercial use of Australian mangrove bark have not met with success, owing to the high freight in shipping the bark to countries equipped with plant suitable for treating the bark, but the present plan contemplates conveying the bark to a factory near the trees, where it can be dried and crushed, and the cutch made into solid extracts, which can be more easily exported. It is estimated that 240 tons of bark will produce 45 per cent. of cutch. It is said that Queensland is in a position to compete, under favourable conditions, with the principal sources of mangrove supplies, that is to say, the east coast of Africa, North Borneo, etc.

THE PRODUCTION OF TUNA CHEESE IN MEXICO.—The tuna cheese industry has been of importance in Mexico from time immemorial, and San Luis Potosi has long been the great tuna market of that country. The tuna plant grows spontaneously in San Luis Potosi, Guanajuato, and Zacatecas, on land too dry at present to permit of much other vegetation. In some parts of San Luis Potosi it grows in such profusion as to render fair returns to landowners, in spite of the exceedingly low price realised for the fruit. The cheese is made by simply boiling and straining the tuna pulp until the proper consistency is reached. It is of a chocolate colour, pleasant to the taste, wholesome, and slightly laxative. Sometimes nuts or flavours are added, and the product is said to be better when taken with milk. The leaves of the tuna plant, which is of the prickly pear family, are used for fodder or dried and used for fuel. The term "tuna cheese" is descriptive only of the consistency of the product; it is, rather, a confection, and is to be sold in the United States, to which country it is being exported from Mexico in small packages as a confection.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MARCH 1.—LEONARD E. HILL, M.B., F.R.S., "Caisson Sickness and Compressed Air."

MARCH 8.—JAMES CANTLIE, M.A., M.B., C.M., D.P.H., "Plague and its Dissemination." Sir SHIRLEY FORSTER MURPHY, M.R.C.S., will preside.

Wednesday afternoon, at 4.30 o'clock:—

MARCH 15.—Colonel CHARLES EDWARD CASSAL, V.D., F.I.C., "The Adulteration of Food." The Right Hon. the Lord Mayor of London will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

MARCH 16.—CLAUDE HAMILTON ARCHER HILL, I.C.S., C.S.I., C.I.E., "Education in India." The Right Hon. Lord NORTHCOTE, G.C.M.G., G.C.I.E., C.B., will preside.

APRIL 27.—Sir THOMAS HENRY HOLLAND, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India." Lord AVEBURY, D.C.L., LL.D., F.R.S., will preside.

MAY 25.—W. R. H. MERK, I.C.S., C.S.I., LL.D., "The N.W.F. Province of India."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

FEBRUARY 28.—The Hon. Sir RICHARD SOLOMON, K.C.B., K.C.M.G., K.C.V.O., K.C., M.A., High Commissioner for the Union of South Africa, "The Resources and Problems of the Union of South Africa." The Right Hon. LEWIS HARCOURT, M.P., Secretary of State for the Colonies, will preside.

APRIL 4.—Captain R. MUIRHEAD COLLINS, C.M.G., "Australia and her Resources."

MAY 9.—F. WILLIAMS TAYLOR, "Canadian Banking."

CANTOR LECTURES.

Monday Evenings, at 8 o'clock:—

Professor ADRIAN J. BROWN, M.Sc., "Brewing and Modern Science." Four Lectures.

Syllabus.

LECTURE IV.—FEBRUARY 27.—"The Fermentation Process." Previous Treatment of the subject by Dr. G. Salamon in 1888—The Pure Yeast Question in Brewing—Zymase and Modern Views of Alcoholic Fermentation—Nitrogen Assimilation—The so-called "secondary" products of Fermentation, etc.—Conclusion.

Professor J. A. FLEMING, M.A., D.Sc., F.R.S., "Applications of Electric Heating." Four Lectures.

Syllabus.

LECTURE I.—MARCH 6.—"The Laws of Electric Heating, Radiation, and Thermometry." The Transformation of Electric Current Energy into Heat—Joule's Law—Explanation on the Electronic Hypothesis—Necessary Qualities of the Conductor and Conditions for the Production of High Temperature—Laws of Radiation—Stefan-Boltzmann Law—Wien's Displacement Law—The Electrical Measurement of Temperature—Resistance Thermometry—Thermoelectric and Radiation Pyrometry.

LECTURE II.—MARCH 13.—"The Appliances and Processes of Electric Heating." Resistance and Arc Heating—Direct and Inductive Methods—Electric Furnaces of Girod, Heroult, Kjellin, Keller, Stassano, Ferranti, Rodenhauser, and others—Resistance Furnaces for Chemical Operations, both at Moderate and Very High Temperatures—Experimental Models.

LECTURE III.—MARCH 20.—"The Technical Applications of Electric Heating." The Manufacture of Graphite, Carborundum, Calcium Carbide, Quartz Glass, Aluminium, Ferro-Alloys, and Iron and Steel in Electric Furnaces—Electric Welding—Electric Furnaces for Metallurgical and Chemical Operations.

LECTURE IV.—MARCH 27.—"The Domestic Applications of Electric Heating." Electric Water Heating—Its Cost and Economy—Air Heating by Electric Radiators and Convectors—Electric Cooking—Various Systems and Types of Utensil critically discussed—The Advantages and Drawbacks in Comparison with other Methods of Culinary Heating.

ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

May 1, 8, 15, 22.

Dates to be hereafter announced:—

FRANK M. ANDREWS, "Architecture in America."

ARTHUR CHARLES DAVIS, F.C.S., Assoc.Inst.C.E., "The Manufacture and Testing of Portland Cement."

GEORGE B. HEMING, "Art Education in Jewellery and Goldsmithing." Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., will preside.

Professor RAOUL PICTET, "Les Basses Températures."

Sir WILLIAM ABNEY, K.C.B., D.C.L., D.Sc., F.R.S., "The Quantitative Measurement of Colour-Blindness."

HAL WILLIAMS, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

NOEL HEATON, B.Sc., F.C.S., "The Production and Identification of Artificial Gems."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 27...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor Adrian J. Brown, "Brewing and Modern Science." (Lecture IV.)

Geographical, Burlington-gardens, W., 8.30 p.m. Dr. W. T. Grenfell, "Labrador."

Actuaries, Staple Inn Hall, Holborn, W.C., 5 p.m.

TUESDAY, FEBRUARY 28...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) The Hon. Sir Richard Solomon, High Commissioner for the Union of South Africa, "The Resources and Problems of the Union of South Africa."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. E. H. Tutton, "Crystalline Structure: Mineral, Chemical and Liquid." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. A. T. Blackall, "Modern Railway-Signalling: Some Developments upon the Great Western Railway."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. E. W. Harvey Piper, "Lordly Lincoln."

Cold Storage and Ice Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. F. Simpson, "Thermometry in its Application to the Carriage and Storage of Refrigerated Produce."

WEDNESDAY, MARCH 1...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. Leonard Hill, "Caisson Sickness and Compressed Air."

Public Analysts, Burlington House, W., 8 p.m. 1. Annual General Meeting. 2. Messrs. R. Ross, J. Race, and F. Maudsley, "Examination of the Process of Shrewsbury & Knapp for the Estimation of Coco-nut Oil." 3. Dr. A. C. Cumming and Mr. A. Gemmell, "The Estimation of Iron by Permanganate in the Presence of Hydrochloric Acid." 4. Dr. A. Backe, "The Analysis of Sweetened Condensed Milk." 5. Mr. H. S. Shrewsbury, "Note on Henry C. Frey's Method of Estimating Petroleum in Turpentine." 6. Mr. J. P. Batey, "Note on the Formation of Hypoiodites and their Action on Sodium Thiosulphate—A source of error in certain Iodine Titrations." 7. Dr. C. B. Savory will show a new form of Specific Gravity Apparatus.

United Service Institution, Whitehall, S.W., 3 p.m. Major-General H. T. Arbuthnot, "The Crimea Revisited."

Royal Archæological, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. H. H. E. Craster, "The Abandonment of the Roman Wall."

West India Committee, 15, Seething-lane, E.C., 3.45 p.m. Mr. W. Fawcett, "Some Interesting Features of Tropical Vegetation in the West Indies."

THURSDAY, MARCH 2... Royal, Burlington House, W., 4.30 p.m.

Linnean, Burlington House, W., 8 p.m. 1. Dr. Malcolm Burr, "Dermaptera (Earwigs) preserved in Amber, from Prussia." 2. Miss Laura Roscoe Thornely, "Report on the Marine Polyzoa of the Collection made by Mr. J. Stanley Gardiner in the Indian Ocean in H.M.S. 'Sealark.'" 3. Mr. W. M. Tattersall, "On the Mysidacea and Euphausiacea collected in the Indian Ocean during 1905."

Roentgen Society, 19, Hanover-square, W., 8.15 p.m.

Chemical, Burlington House, W., 8.30 p.m. 1. Mr. S. U. Pickering, "Potassium Cupricarbonates." 2. Messrs. M. O. Forster and A. Zimmerli, "Studies in the Camphane Series. Part XXIX. A New Phenylhydrazone of Camphorquinone." 3. Messrs. A. Hopwood and C. Weizmann, "Synthesis of Dipeptides of Lauric Acid with Glycine, Alanine, Valine, Leucine, and Asparagine." 4. Messrs. F. G. Pope and H. Howard, "Fluorone Derivatives." 5. Messrs. F. B. Power and A. H. Salway, "The Constituents of Witharia Somnifera."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. A. C. Benson, "Ruskin." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. C. Davenport, "Illuminated Manuscripts."

Philatelic, 4, Southampton-row, W.C., 6 p.m. Mr. F. J. Peplow, "Display of the 1871–6 Issues of Japan on Entires, with Notes on the Cancellations."

FRIDAY, MARCH 3... Royal Institution, Albemarle-street, W., 9 p.m. Dr. F. A. Dixey, "Scents of Butterflies."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. H. Ellis Hill, Jun., "Lagos Harbour Survey, 1909–1910."

SATURDAY, MARCH 4...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Radiant Energy and Matter." (Lecture I.)

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FRIDAY, MARCH 3, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 6th, 8 p.m. (Cantor Lecture.) Professor J. A. FLEMING, M.A., D.Sc., F.R.S., "Applications of Electric Heating." (Lecture I.)

WEDNESDAY, MARCH 8th, 8 p.m. (Ordinary Meeting.) JAMES CANTLIE, M.A., M.B., C.M., D.P.H., "Plague and Its Dissemination." Sir SHIRLEY FORSTER MURPHY, M.R.C.S., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURES ON "BREWING."

On Monday Evening, February 27th, Professor ADRIAN J. BROWN, M.Sc., delivered the fourth and last lecture of his course on "Brewing and Modern Science."

On the motion of the Chairman, a vote of thanks was accorded to Professor BROWN for his interesting course.

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

TUESDAY AFTERNOON, FEBRUARY 28th, the Right Hon. LEWIS HARCOURT, M.P., Secretary of State for the Colonies, in the chair. A paper on "The Resources and Problems of the Union of South Africa" was read by the Hon. Sir RICHARD SOLOMON, K.C.B., K.C.M.G., K.C.V.O., K.C., High Commissioner for the Union of South Africa.

The paper and discussion will be published in a subsequent number of the *Journal*.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

COVERS FOR JOURNALS.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1*s*. 6*d*. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

TWELFTH ORDINARY MEETING.

Wednesday, March 1st, 1911; ERNEST WILLIAM MOIR, M.Inst.C.E., in the chair.

The following candidates were proposed for election as members of the Society:—

Curtis, Miss Gertrude M., 5, Victoria-street, S.W.

Hayward, Johnson, Tuesley Lane Cottage, Godalming, Surrey.

Hebdon, William, 56, Tresillian-road, St. John's, S.E.

Johnston, Edward Hamilton, I.C.S., Terlings, Harlow, Essex.

Willott, Frederic John, The Aluminium Corporation, Limited, Wallsend-on-Tyne.

The following candidates were balloted for and duly elected members of the Society:—

Bell, Thomas, Messrs. John Brown & Co., Ltd., Clydebank, Scotland.

Byrne, James, 24, Broad-st., New York City, U.S.A.

Cookson, Clive, Oakwood, Wylam, Northumberland.

Dubilier, William, 431, Lumber Exchange Building, Seattle, Washington, U.S.A.

Lee, Harold, 56, Oxford-street; and Fairfield, Broughton Park, Manchester.

Lello, Thomas Stanley, High-road, Chadwell Heath, Essex.

Mackay, Robert John, Secretary's Office, General Post Office, E.C.

Mansell, Walter H., 405, Oxford-street, W.

Pitt, T. E. Sandford, Calne, Wilts.

Srivastava, Jwala Prasad, B.Sc., Municipal School of Technology, Manchester.

Sunderland, John Samuel, 37, Aberdeen-road, Highbury Park, N.

Todd, John, Hamilton House, 155, Bishopsgate, E.C.

The paper read was—

CAISSON SICKNESS AND COMPRESSED AIR.

By Leonard Hill, M.B., F.R.S.

Attention was first called to caisson disease or compressed-air sickness in the middle of last century, when Triger applied the use of compressed-air caissons to the sinking of coal shafts through the wet soil at Chalons on the banks of the Loire. Hoppe Seyler (1857) and Thos. Schwann (1858) in Germany, and Bucquoy (1861) in France, gave the first correct suggestion as to the cause, viz., that it was due to the setting free of bubbles of gas in the blood. Nitrogen gas is dissolved, according to the law of partial pressures, during exposure to the compressed air, and this dissolved gas having no time to escape through the lungs, if the pressure be suddenly lowered, bubbles off just as carbonic acid escapes from aerated water when a bottle is uncorked.

The voice of these men was as that of the prophet in the wilderness; the large majority of medical writers, ignorant of physical laws, held that exposure to compressed air mechanically alters the distribution of the blood, forcing it inwards and causing a congestion of the viscera, which is suddenly and dangerously altered on decompression.

In 1879 Paul Bert published his great work "La Pression Barométrique," in which he described an admirably-contrived series of experiments on animals which proved, once and for all, (1) that the mechanical effects of compressed air are negligible; (2) that during exposure to 8 to 9 atmospheres there is no ill effect until the partial pressure of oxygen dissolved in the blood reaches such a point that it acts as a tissue poison; (3) that pathological accidents occur only after decompression, and are due to bubbles of nitrogen appearing in the blood and interfering with the circulation; (4) that these effects can be prevented by making the rate of decompression slow enough.

After Bert's death, Philippon and others in France confirmed his work, but in England, and particularly in America where many great caisson works were initiated, engineers remained in ignorance of Bert's great work, and the mechanical theory held sway. In Germany von Schrötter, Heller and Mager published in 1900 a valuable work, in which they collected all the data then available. They established the clinical picture of compressed-air illness, and explained in full its protean nature, and showed how this depends on the ischæmia produced by bubbles interfering with the circulation in one or other part of the body. In particular they demonstrated that the paralysis, so often produced (diver's palsy), is due to a local death and degeneration of the spinal cord, produced by bubbles blocking the circulation there. They laid down the principle that a uniform decompression at the rate of two minutes per 0·1 atmosphere was safe, basing their calculations on a law of saturation and desaturation of the body, which had been enunciated by Zuntz (1897). Two years earlier, in 1898, I began the experimental study of this subject in England, and by my experiments independently established the truth of Bert's conclusions and overthrew the mechanical doctrines which were generally held here and America. For the last fifteen years I have continued researches on the subject, and I now propose to give you the chief results of these. Before doing so I may state that in 1899 Lorrain Smith greatly advanced our knowledge of oxygen poisoning by showing that very long exposure (for two days or so) to a partial pressure of 75 per cent. to 100 per cent. of an atmosphere produces a fatal inflammation of the lung, while short exposures to over 2 to 3 atmospheres of oxygen quickly produces the same effect (180 per cent. of an atmosphere in twenty-four hours, 300 per cent. in five hours). E. W. Moir reported that mules lived for a year in the Hudson Tunnel, where the partial pressure of oxygen was about 60 per cent. of an atmosphere. They remained in perfect health.

In 1907 Vernon made a very important contribution by showing that oil or fat exposed to air takes up in solution over five times the volume of nitrogen and oxygen that water does. In the same year Haldane, with Boycott and Damant, for the Admiralty Committee on deep-water diving, made an equally important contribution, in which they showed (1) that the deep-water diver hitherto had not been given a sufficient air supply and had in consequence suffered from excess of carbon dioxide. (2) That the legs of his dress required lacing up to prevent his being blown up helpless from the bottom by too big an air supply. (3) That the saturation of the body in compressed air was much slower than generally thought. (4) That safety lay in making the exposure a short one for deep-water work (previously insisted on by Catsaras). (5) That it is safe to decompress rapidly from the maximum absolute pressure to half this pressure, the second stage of decompression being made slow enough to allow the

supersaturated blood to give up the nitrogen to the lungs.

After this brief introduction I will now give an account of the chief experiments I have carried out with the help of first one and then another colleague—J. J. R. Macleod, C. E. Ham, M. Greenwood, F. Twort, and H. B. Walker.

Disproof of Mechanical Theory.—(1) I enclosed a frog's heart in a small chamber with thick glass windows, and showed that it continued to contract in a normal manner at a pressure of even 50 atmospheres. Similarly I showed that a frog's muscle could be excited to contract normally in like conditions. (2) In caterpillars, air is conveyed directly to the body cells by finely branching tracheae. Their circulating liquid is not respiratory in function. Sudden decompression from 27 atmospheres had no ill-effect on these, unless they had eaten leaves while under pressure. Then they were burst by the swelling of the swallowed bubbles (Greenwood). (3) I enclosed a narcotised dog or cat in a pressure chamber, having first connected its carotid artery with a mercurial manometer, and set the manometer recording on a clockwork drum, the manometer and drum both being put inside the chamber. I showed that the blood pressure and pulse beats exhibited no noteworthy change on raising or lowering the pressure 2 to 3 atmospheres (confirmation of Bert). (4) I contrived a chamber with glass windows, in which I placed a frog so that the web of its feet might be illuminated with an arc light and projected microscopically on to a screen. I found that the circulation in the capillaries did not alter when the pressure was raised quickly or lowered 20 atmospheres and even 70 atmospheres.

Proofs that Nitrogen Bubbles are the Cause of the Illness.—(1) By the same means I demonstrated both the setting free of nitrogen bubbles in the blood on decompression, and the fact that they can be again driven into solution by recompression — for on suddenly decompressing after a long exposure I had the keen pleasure of seeing the bubbles appear in the capillaries, grow in size and stop the circulation, to shrink and disappear again on putting up the pressure (*Proceedings of the Royal Society*, vol. lxx., p. 454, 1902). This experiment was repeated by Sir Thomas Oliver (*Journal of the Royal Society of Arts*, May 11th, 1906, vol. liv.). (2) Macleod and I enclosed narcotised dogs in a pressure chamber, having first connected the carotid artery to a tap so that we could draw off samples of blood into a vacuum pump and analyse the blood gases. We then confirmed Bert's observations, and showed that the nitrogen dissolved in the blood varies with the partial pressure, roughly 1 per cent. of nitrogen is dissolved per atmosphere. By the same method we studied the giving-off of nitrogen from the lungs during decompression. (3) C. Ham and I killed rats by rapid decompression from 10 atmospheres, and chopped up their bodies under water, collecting the gas set free in their bodies under a funnel full of water. We found 80 to 90 per cent. of the gas was nitrogen, and the rest chiefly carbon dioxide with a trace of oxygen, *e.g.*, 10·7 to 16 per cent. CO_2, 2·1 to 4 per cent. O, 87·2 to 80 per cent. N. The gas obtained was more than there ought to have been according to the law of partial pressures and the volume of water in the body. This excess we found was partly due to gas, swallowed or set free by fermentation, in the alimentary canal. Part of the excess, no doubt, was due to the greater solubility of nitrogen in fat, a fact then undiscovered. (4) We killed mammals by rapid decompression, and, opening the right side of the heart under water, analysed the gas obtained and showed it was 80 to 90 per cent N, the rest being carbon dioxide with only a trace of oxygen. The carbonic acid escapes from the blood because the nitrogen set free acts as a vacuum in regard to CO_2. The oxygen chemically unites with and is used up by the blood, and therefore is only found in small amount (confirmatory of von Schrötter). (5) Greenwood and I showed that rats and frogs, if submitted to high pressures of oxygen *until poisoned* by it, and then rapidly decompressed, have considerable amounts of dissolved oxygen set free in their bodies. This never occurs with low pressures of air, and oxygen bubbles are not a factor in caisson sickness. (6) We also showed that animals killed by decompression in 3 to 5 seconds from + 7 to 8 atmospheres have gas bubbles in the fat droplets of the tissue cells, such as the liver and kidney, which actually vacuolise and disrupt the structure of the tissue cells. The liver and kidney may appear foamy with bubbles in such case. The fat, too, in all cases of rapid decompression, is honeycombed with bubbles, like whisked white of egg. Alveoli of the lungs, too, may be ruptured and lobules rendered emphysematous by the violent expansion of the air within them. Much gas is set free in the alimentary canal, and in small animals, as the rat, within the peritoneal cavity. The blood

vessels are filled with columns of bubbles. Such a distribution of gas may be found in men killed by bursting of caissons. (7) Comparing big rats with small rats, pregnant with virgin rats, and mice with rats, we found the danger of rapid decompression increases with body weight. An herbivorous animal, the guinea-pig, too, is more susceptible than a kitten of the same weight. A. Smith found the heavier and older men more susceptible at the Brooklyn Works.

Boycott and Damant have since shown that the risk varies as the fatness of the animal. This we have recently found to hold good with pigs. Fat pigs weighing 100 to 120 lbs. are more susceptible than smaller pigs of 50 to 60 lbs. The bubbles once set free in the fat of pigs may stay there for days after decompression, as we have found to our cost, for it has seriously damaged the sale of the animals to the butcher, since the fat does not bleed properly and remains pink.

Vernon showed that fat exposed to 1 atmosphere dissolves about five times the amount that water does. F. Twort and I have shown that this holds good up to 7 atmospheres.

The following are the figures we obtained:—

50 c.c. olive oil (specific gravity ·917) were shaken at +95 lbs. for 38 minutes, and allowed to stand at +95 lbs. for 2½ hours. Room temperature, 17·3° C. The gases were then extracted from a sample.

Volume of gases (N.T.P.).	Calculated on Vernon's results.
N 35·55	39·21
O 18	17
CO_2 1·62	1·491

Time spent in collecting sample, 1 minute. Pressure fell 2½ lbs. during collection. The rest of the oil was left for three day sat +92 lbs., falling to +84·5 lbs. The sample gave:—

Volume of gases (N.T.P.).	Calculated on Vernon's results.
N 33·61	35·53
O 15·56	15·4
CO_2 1·55	1·35

The oil gave a slow evolution of visible bubbles after reduction of the pressure in 10 minutes from + 90 to + 20 lbs., even without any oscillation of the chamber. All the results give further proof that fat men should be excluded from caisson work. The varying percentage of fat in the blood, chyle, liver, must be an important factor in the evolution of bubbles in the blood of compressed-air workers. The less fat in the food eaten in the caisson the better.

Oxygen Poisoning.—(1) I showed that all kinds of animals, worms, snails, flies, spiders, frogs, etc., are instantly convulsed and killed by exposure to 50 atmospheres oxygen. (2) The frog's heart beats, nerve conducts and muscle contracts for some time in 50 atmospheres O, but there is evidence of progressive diminution in functional power, the muscle behaving like a fatigued muscle. The central nervous system is, as Bert showed, the first point of attack of high pressures of oxygen. (3) Mice exposed to 10 atmospheres O are thrown into tetanic spasm, and on being decompressed continue to be convulsed by a touch. Bubbles of oxygen are to be then found in the central nervous system compressing the nerve cells. As the bubbles are oxygen the cells do not die and the animals may recover, the oxygen being absorbed by the tissues and the circulation re-established. (4) + 3 atmospheres O convulsed animals in 30 to 60 minutes (so Bert and Lorrain Smith), and the poisonous effect, depending as it does on the partial pressure of O in the blood, comes on just as soon in larger animals as in small, *e.g.*, cats, rats, and mice. (5) Fatal inflammation of the lung is produced by exposure to high partial pressures of oxygen, *e.g.*, after 25 hours continuous exposure to + 7 atmospheres of air = 170 per cent. of an atmosphere O (confirmation of Lorrain Smith). This can be prevented by using nitrogen to dilute the air, and so lowering the partial pressure of oxygen. (6) It is quite safe to breathe 1 atmosphere oxygen, or 5 atmospheres air, for 3 to 4 hours. The men who wear the Fleuss apparatus for rescue work in mines have breathed it day after day for this period. I have spent much time in perfecting this apparatus on physiological lines, and so have studied particularly the effect of oxygen on man. In very hard work there may be a deficiency of the oxygen supply in the body, and then breathing oxygen helps the working power of the man.

If the body is getting enough oxygen the breathing of it has no effect on the metabolism. The resting man cannot be fanned into a greater rate of activity by breathing oxygen. Poisonous pressures of oxygen lower the metabolism and diminish the carbonic acid output of animals. M. Flack and I showed that the breathing of oxygen just before a race may help an athlete, because during his great effort he uses up oxygen quicker than his respiration and circulation can provide it. A shortage of oxygen leads to the production of acid products in the tissues and blood, which causes breathlessness and stiffness of the muscles (Ryffel).

Carbon Dioxide and Temperature of Air in Caissons.—Much has been made of CO_2 as a contributory cause of caisson disease. Mr. E. W. Moir, the distinguished engineer, one who has the greatest practical knowledge of compressed-air work, has drawn particular attention to this. M. Greenwood and I have exposed ourselves to compressed air and allowed the partial pressure of CO_2 to rise to 1·8 per cent. of an atmosphere, without any inconvenience. We have exposed cats and dogs to as much as 4 per cent. CO_2 without untoward results, beyond increased frequency of respiration. Recently I have carried out many experiments on students sealed up in a small air-tight chamber, and found that it is the heat, moisture and stillness of the air which cause discomfort and fatigue, and not the excess of CO_2, or deficiency of oxygen in the air breathed. The putting on of powerful electric fans by whirling the air and cooling the body gives very great relief, even when there is 4 to 5 per cent. of CO_2 in the chamber (confirmatory of Haldane's work).

Hot, moist, still air causes fatigue by taxing the cooling mechanism of the body; blood is sent to the skin to be cooled which ought to be going to muscle and brain; a higher blood-pressure has to be maintained to effect this, and this fatigues the heart. Fatigue increases the danger of decompression by making the circulation and respiration less efficient. The heat causes more blood to come to the skin and a more complete saturation with nitrogen there. The cold in the decompression chamber—due to expansion of the air—causes vaso-constriction and repels the blood from the skin and so stops its desaturation. We have lost pigs by taking them from the warm caisson into the cold air.

Over hot and moist—that is, under-ventilated—caissons have, therefore, a higher morbidity. The wet-bulb temperature must be kept below 75° F., and if possible well below 70° F. (Haldane). The men should not pass from a warm caisson to a cold air-lock and a cold outside world. They should go through a warm lock to a warm room.

Hot moist atmospheres are very disadvantageous to health and work. If the wet-bulb temperature is high in the caisson, the current of air should be increased or electric fans used to cool the workers. Electric fans have enormously increased the efficiency and health of Europeans in the tropics. (2) An excess of CO_2 in the air-lock, or diver's helmet, during decompression is favourable, as it increases the pulmonary ventilation and the outbreathing of nitrogen. Haldane advises the air-pump to be slackened purposely. There is no harm in breathing 0·5 to 1 or even 2 per cent. of an atmosphere of CO_2. (3) The diver requires, as Haldane showed, one, two, three, and even four pumps to maintain an adequate ventilation in his helmet as he goes deeper. If there is four times as much air compressed in his helmet he must have four times as much air pumped through to wash out the CO_2 and prevent him becoming breathless with excess. The working of three or four pumps means many men and much labour. I have suggested in place of many pumps the use of a chamber containing caustic soda carried on the back of the diver, and an injector on the inlet of the helmet, so arranged as to suck the air in the helmet through the caustic soda and absorb the CO_2. Messrs. Siebe, Gorman & Co. have made the first trials of this suggestion. One pump with this device should be enough for deep work.

R. H. Davis, of the above firm, and I have contrived also a self-contained diving-dress fitted with cylinders containing 50 per cent. oxygen, and a caustic soda chamber. The oxygen supply lasts an hour, and the same injector plan is used in this dress to purify the air. A telephone wire, but no life-line or air-pipe is carried, and this makes the dress suitable for exploration of flooded mines, tunnels, etc. By using 50 per cent. oxygen there is no risk of oxygen-poisoning if the dress is used at depths not exceeding seventy to eighty feet (Haldane). It would, I think, be safe to use it at 100 feet for half an hour.

Recompression as a Cure.—Macleod and I found that we could restore animals on the point of death, after too rapid a decompression, by quickly recompressing them to the former pressure. Dangerous cases brooked no delay, for the vital parts cannot stand interruption of the circulation for more than a very few minutes. On the frog's web I observed how the bubbles shrink up on recompression and expand again on decompression.

F. Twort and I have observed microscopically, and measured bubbles set free in water or oil, after decompression from + 90 lbs. On recompression the bubbles shrink and the volume, calculated from the diameter, varies inversely as the pressure, following Boyle's law. The surface tension of the skin of the bubble has no noteworthy disturbing effect. The bubbles appear as small ones, about 0·1 to

0·2 mm.; they form round dust particles and roughnesses of the wall, and run together to form larger ones. On recompression, some of these bubbles persist when the pressure is raised again to +90 lbs., and enlarge again on lowering the pressure. This shows why, after recompression of a case of caisson sickness, the decompression must be made very slowly.

A. Smith suggested the use of a medical lock or recompression chamber at Brooklyn. In the first French caissons it had been noted that the men went back into the caissons to get relief from bends.

E. W. Moir instituted the medical lock in all the works in his charge, brought it into prominence, and by its means has effected great saving of life and suffering. Some of the cases he has kindly reported to me have been in truth of men raised from the dead.

For deep-diving work I contrived with Messrs. Siebe, Gorman & Co. a decompression chamber. This consists of a double-chambered diving-bell, one chamber (A) open at the bottom to the sea, the other (B) closed save for a manhole communicating with (A). The bell is lowered to the bottom, and the divers, after completing their work, enter (A), and from thence pass into (B) and close the manhole. The bell is then raised on deck and (B) is slowly decompressed. A recompression chamber ought to be on hand in all important deep-sea diving works. The men engaged in caisson works—run at dangerous pressures—should have barracks at the works, and remain there after the shift so that they may be at once recompressed on first sign of illness. The onset of illness is often delayed even for an hour or more, for it depends on the accumulation of bubbles and stoppage of the circulation in some vital part.

In experiments on pigs we have several times lost the animals on their way home to the farm, after we had, as we thought, safely decompressed them. We have failed to cure pigs, dangerously affected, by recompression, when the interval has been more than a very few minutes.

Direct Effects of High Pressures.—As all our experiments showed that dogs, cats and monkeys could be safely decompressed at a rate of 20 minutes per atmosphere from +100 lbs., M. Greenwood and I went under pressure ourselves. A suitable chamber was supplied us by Messrs. Siebe, Gorman & Co., who have helped us in every way and most generously. We owe a special debt of gratitude to Mr. R. H. Davis, the managing director. We used a steel boiler (volume 42·2 cubic ft.) fitted with a telephone. In this one or other of us were exposed on eleven occasions to pressures above +60 lbs., four times to +75 lbs. (M. Greenwood once went to + 92 lbs.). We were actually exposed to above + 60 lbs. for half an hour, and were virtually exposed for nearly an hour if we take into account the time of compression, which was slow. We were safely decompressed by the uniform method (about 20 minutes per atmosphere), only on two occasions suffering from minor local symptoms. From + 92 lbs. M. Greenwood was decompressed in 2 hours 17 minutes. Damant and Catto have since dived to the corresponding depth in the sea, and have been decompressed safely by the stage method. We found there is no sense of pressure, *e.g.*, it is not possible to tell + 3 from + 5 atmospheres. The voice becomes very high pitched and nasal in quality, whispering and whistling impossible.

The respiration is normally regulated by the partial pressure of carbonic acid in the alveoli of the lungs, on which depends the concentration of acid in the blood passing through the respiratory centre in the brain. Normally the partial pressure of CO_2 equals about 5 per cent. of an atmosphere. We found this held good up to + 75 lbs. pressure.

Percentage of CO_2 found on analysis of alveolar air of lung.	Pressure in lbs.	Percentage found multiplied by pressure in atmospheres.
5·3	+ 0	5·3
0·9	+ 75	5·4
1·0	+ 60	5·0
1·8	+ 30	5·4
2·7	+ 15	5·4
5·4	+ 0	5·4

We collected and analysed our alveolar air while in the caisson, and it was rather astonishing to observe the percentage of CO_2 fall as the pressure rose from 5·4 at 1 atmosphere to 0·9 at 6 atmospheres.

Methods of Decompression.—Saturation of the body with nitrogen depends on the relation between the circulating blood volume (the velocity with which the volume circulates) and the mass of the absorbing tissue fluid. The shorter time it takes for the blood to go round the body, the greater is the volume of the blood circulated per minute through the lungs and tissues. During saturation the blood carries the nitrogen from the lungs to the tissues; during desaturation it carries it from the tissues to the lungs. The rate of the circulation varies

in different organs, and so the saturation time varies. There are parts quickly and parts slowly saturated. The fat absorbs five times as much as the watery tissue, and therefore takes much longer to saturate and desaturate (Vernon).

The brain and spinal cord have much fat in the myelin of the nerve sheath. But as the brain has a more active circulation than the spinal cord, the white matter of the spinal cord is a commoner seat of bubbling, which leads to ischaemia, degeneration of the tissue, and paralysis.

According to Haldane, the whole body is about half saturated in half an hour, and about saturated in 4 hours. Bornstein thinks 6 to 7 hours are required for saturation of the fat. Bodily work, by increasing the circulation and pulmonary ventilation six times, or more, enormously reduces the time of saturation. Warm, moist caissons, by dilating the skin vessels and increasing perspiration, accelerate the circulation in the periphery, and make the saturation there far more rapid than in a man exposed to cool wind. The diver is surrounded by cold water. the caisson workman by warm, moist air. The latter generally works much harder and longer hours, and therefore suffers far more from "bends." The diver goes to much greater pressure for short times, and after quick decompression may suffer from asphyxia or paralysis—from bubbles in the heart or spinal cord.

Greenwood and I studied on ourselves the saturation of a quick part—the kidney. When the kidney is actively secreting, the saturation of the urine must approximate to that in the arterial blood.

One of us drank two pints of water, and half an hour later was raised to + 45 lbs. He then emptied his bladder, and ten minutes later emptied it again. The urine filled a glass receiver, which was sealed, and the gases were extracted from it afterwards with the gas-pump. By this device samples of urine actually secreted in definite intervals, after a given pressure limit had been reached, were available for analysis. The results showed us that the kidney—in a state of activity—is about saturated in 10 minutes.

We were decompressed at a rate of 20 minutes per atmosphere, and our urine showed that desaturation lagged behind the fall in pressure. Our urine still contained an excess of gas at the end of decompression.

It is assumed that the blood is saturated, or desaturated, each time it passes through the lungs. The Admiralty tables of stage decompression are based on this assumption.

Figures which F. Twort, H. B. Walker, and I have obtained make it doubtful whether this is so. We breathed oxygen for 35 minutes and until there was only 10 per cent. nitrogen left in the alveolar air of the lungs, and collected the urine *secreted then*. The amount of nitrogen dissolved under 1 atmosphere of air at body temperature is reckoned to be 0·825 per cent. (Bohr). We actually found 0·878 per cent., using the Buckmaster and Gardner gas-pump, which gives the least possible source of error. After breathing the oxygen, we found 0·257 per cent., and on another occasion 0·316 per cent. We should expect to find, with a partial pressure of only 10 per cent. atmosphere N, about 0·11 per cent. Either this extra nitrogen came from the kidneys, they having retained it, or else from the arterial blood.

The same lag is found in decompression experiments, and, considering the freedom of the diuresis, it is doubtful whether the kidneys can have retained all the excess of nitrogen, and it seems highly probable that the blood does not desaturate completely during its passage through the lungs.

In dealing with this problem, the following came into consideration:—

The two kidneys contain about 170 grm. of tissue water and perhaps 20 grm. of fat. As the fat has five times the saturation power for nitrogen, the solvent power of the kidneys would be equivalent to about 270 grm. of water. About 100 grm. of urine is passed each time, and a great volume of blood is circulating through the organs.

Time.	Pressure in lbs.	Per cent. N. in Urine.	Per cent. N. calculated.
4. 0	+ 45	3·93*	3·47
4. 6 – 4.12	Decompressed to 13	—	—
4.13	+ 13	3·7	1·62
4.22	+ 13	2·62	1·62
4.28	+ 13	2·30	1·62
4.34	+ 13	1·87	1·62
4.43	+ 13	1·80	1·62
4.45 – 4.52	Decompressed to 0	—	—
4.55	+ 0	1·64	0·825
5. 0	+ 0	1·28	0·825

On decompressing a resting animal, the nitrogen should be given up by diffusion from the lungs in the same time as that required for saturation. Now the viscosity of the blood

* The error of analysis makes the readings too high by 0·2 to 0·3.

prevents the formation of bubbles under a certain strain; hence it is safe for a man to be rapidly decompressed after exposure to about + 18 lbs. (general experience of caissons).

It is safe, therefore, to come rapidly from 30 to 15 lbs. (absolute), or half-way. Since the volume of a gas is halved at 2 atmospheres, made one-fourth at 4 atmospheres, one-eighth at 8 atmospheres, and the volume of a bubble is doubled on lowering the pressure from 8 to 4, 6 to 3, 4 to 2, or 2 to 1, Haldane concluded it was safe to come rapidly from 4 to 2, 6 to 3, or 8 to 4 atmospheres. The supersaturated tissues then give nitrogen to the blood, and the blood to the lungs, and the nitrogen escapes without bubbling at the half-pressure stage, where a long pause is given.

This stage method of decompression is of great value to divers, who only go down for a short period and do not work very hard, for it prevents the saturation of slow parts. The men are decompressed from the dangerous pressure to one half of it before the slow parts (fat, etc.) are saturated.

Caisson workers work hard and for long shifts, which means they are practically saturated. The Admiralty Committee, by experiments on goats, found a great superiority of the stage over the uniform method of 20 minutes per atmosphere, and established detailed tables of decompression on the strength of these experiments. These tables are drawn up, and give times of decompression with a great appearance of exactitude. They are based on theoretical assumptions as to the circulation time, volume of blood, desaturation of the blood in its passage through the lungs. As bodily activity has a most potent effect on the circulation, increasing the rate perhaps six or ten times, and converting "slow" parts into "quick" parts, it seems clear that the tables have only a limited accuracy. As I have pointed out above, the fact that the blood is desaturated in its passage through the lung requires proof.

Goats, moreover, are not the best animals for comparing with man, because of their chewing the cud, which leads to the swallowing of much air, and this, coupled with production of gas by fermentation, leads often to great distension of their viscera on decompression. We have lost several goats from this cause.

Greenwood and I chose, for investigation, pigs, which are more like men in shape, diet, and habit. We found no pronounced superiority of the stage over the uniform method. The pressure was + 75 lbs., the time of decompression 90 to 110 minutes, the same as that used in the Admiralty Committee's goat experiments. There were 4 fatal or dangerous cases in 20 uniform, 9 in 32 stages, and 9 in 44 modified uniform, decompression rate slowing in proportion as pressure falls.

Using a longer period, we have found it fairly safe to decompress pigs or goats by a one-stage method from + 75 lbs. The method was + 75 to + 18 lbs. in 10 minutes, and + 18 to + 0 lbs. in 20 minutes, after an interval of 80 to 100 minutes. One death and no severe case resulted in 47 pigs weighing 50 to 100 lbs., 1 severe and 3 slight cases in 19 goats weighing 39 to 57 lbs.

Similar decompression of fat pigs from + 90 lbs., allowing an interval of 105 to 120 minutes at + 18 lbs., gave unfavourable results—7 deaths and 1 severe case in 27 pigs. These pigs weighed 81 to 115 lbs., and the fact that they were very fat and never moved during decompression told greatly against them.

Only one pig out of all showed any symptoms after being decompressed in 10 minutes to the stage at + 18 to 20 lbs. It is therefore safe to use the stage method for a man; the only question to settle is the duration of the stage and the handling of the second part of the decompression.

Bornstein has compared the stage and the uniform method at the Elbe Tunnel Works (+ 2 atmospheres).

Days.		Workers	Cases of Illness.	Illness per Day.
20	Stage	526	15	0·94 ? 0·75
16	Uniform	528	17	1·21 ? 1·06
18	Stage	529	12	0·67
16	Uniform	529	14	0·88
14	Stage	536	12	0·86

The figures show a slight advantage for the stage method, but it is within the limits of error, for the number of cases from time to time vary widely in caisson works. Bornstein has got much better results by making the men climb a ladder 25 metres high immediately after decompression, so as to excite the circulation and pulmonary ventilation.

No Climbing after Decompression.

Days.	Workers.	Cases of Illness.	Illness per Day calculated on Basis of 1000 Workers.
31	527	56	3·37
33	529	43	2·13
13	536	17	2·26

CLIMBING AFTER DECOMPRESSION.

Days.	Workers.	Cases of Illness.	Illness per Day calculated on Basis of 1,000 Workers.
24	407	4	0·39
27	338	17	1·80
13	328	4	0·87
13	162	4	1·79
12	112	1	0·59

In this respect I note that Mr. Francis Fox states that when he visited the St. Louis Works (57½ lbs.), he found the morbidity greatly lessened by the substitution of lifts for climbing after decompression.

I do not think violent exercise would be wise *after* too short a decompression from a high pressure. Making our pigs struggle has several times brought on symptoms. The exercise should be given during the stage interval.

8,500 man shifts were decompressed by Japp at the East River Tunnel, New York, by a stage method—from + 40 lbs. in 48 minutes. There were 1·62 per cent. cases and no serious ones. The method used was—(1) + 40 to + 29 lbs. in 5 minutes; (2) 10 minutes' walking in + 29 lbs.; (3) + 29 to + 12½ lbs. in 8 minutes; (4) 10 minutes' walking in + 12½ lbs.; (5) + 12½ to + 0 in 15 minutes. Lengths of tunnel were arranged between locks for walking in. The Admiralty table ordains 92 minutes for this pressure. Half this time, evidently, is enough, and no doubt less if the men were made to do hard muscular exercise during the stages.

Bornstein calculates the same volume of nitrogen expelled by uniform decompression in 1 minute would be expelled by stage decompression in 0·5 to 0·6 minutes.

Breathing oxygen	—	0·35 min.
Forced breathing	0·5 to 0·9	,,
Light bodily work	0·2 to 0·25	,,
Heavy ,, ,,	0·1 to 0·2	,,

Greenwood and I, in the experiments on ourselves, realised the importance of muscular work, and by exercising ourselves were decompressed safely from pressures which have proved dangerous for fat, somnolent pigs. We in vain tried to make the pigs exercise by giving them electric shocks. I have no doubt that the best method to shorten decompression safely is to make the men work during decompression. They should be made to climb at the half-pressure stage.

Breathing Oxygen to Hasten Decompression.—F. Twort, H. B. Walker, and I have investigated this by the urine method. We have breathed oxygen during uniform and stage decompression, and observed its effect by analysis of the nitrogen gas in the samples of urine collected every 7 minutes.

Oxygen helps to clear the nitrogen out, as this experiment shows:—

Time.	Pressure in lbs.	Per cent. N. in Urine.	Per cent. N. calculated.
12.50	45	3·83	3·47
12.53 – 12.57	Decompression to 30	—	—
12.57 – 1. 1	Decompression to 15. Breathed oxygen for 2 min.	—	—
1. 2	15	3·22	1·70
1. 4 – 1. 7	Breathed oxygen	—	—
1. 9	15	2·13	1·70
1.10 – 1.15	Decompression to 10. Breathed oxygen for 3 min. Oxygen supply then gave out.	—	—
1.16	10	1·63	1·42
1.23	10	1·45	—
1.30	10	1·76	—
1.32 – 1.39	Decompression to 5	—	—
1.37	5	1·61	1·12
1.40 – 1.44	Decompression to 0	1·35	0·825

Bornstein has breathed oxygen (90 to 95 per cent.) for 48 minutes (at + 2 atmospheres), and two engineers at the Elbe Tunnel breathed it for 30 minutes. These important observations show the limit to which such high partial pressures of oxygen can be breathed safely by man. Bornstein has found the time limit given above must not be overstepped. He freed himself from "bends," after 8 hour exposures to + 2 atmospheres, by using oxygen.

The oxygen can be breathed economically by the use of the Fleuss apparatus,* which was used so effectively in the last great colliery disaster at Bolton. This apparatus can be put on in the works and oxygen breathed for 10 minutes before and again during decompression. This, coupled with active exercise to excite the circulation, ought to clear out most of the nitrogen in a very few minutes. For every atmosphere the body dissolves nitrogen to about 1 per cent. of its mass—for a 70 kilogramme man, say, 700 c.c. per atmosphere. Von Schrötter calculates that oxygen plus muscular exercise would turn out 1,000 c.c. in 5 minutes, probably more. We are at present investigating this interesting point.

Oxygen is now made from liquid-air plant, and it ought to be feasible to put up a plant in important

* I have invented a simple oxygen generator and inhaler, by means of which a bag of oxygen can be made by the action of water on oxylithe ($NO_2 O_3$). This could be used easily in a caisson.

works, and use oxygen in the air-locks for deep work *under expert medical advice.* By using oxygen, and exercise in the air-locks, work might be done at a depth considered now to be dangerous.

Length of Shift.—It is generally held that length of shift increases risk (E. W. Moir, Bornstein). Bornstein says he can be decompressed from + 2 atmospheres in 20 seconds after 50 minutes exposure, while he suffers from "bends" after 8 hours exposure if decompressed in 20 minutes per atmosphere. Bends, no doubt, are due to saturation of the peripheral "slow" parts. Bornstein says a much slower rate is needed for 8 hours than for 1 to 2 hours or 2 to 4 hours shift. To prevent bends, no doubt this is the case, but I doubt whether there is evidence that dangerous cases are much more frequent with 6 to 8 than with 3 to 4-hour shifts. The question of saturation is complicated by that of fatigue: a long shift fatigues the circulatory mechanism and makes it inefficient during decompression.

Neither the tables of the goat experiments of Boycott, Damant, and Haldane, nor the tables of Keays concerning the 557,000 man-shifts at the East River Tunnels, give conclusive evidence that shifts of 3 hours are more dangerous than 1½, or 8 than 3.

The variations in percentage of cases, even when calculated from groups of 3,000 to 4,000 man-shifts, are very large, *e.g.*, 8-hours shift 0·43 per cent. May, 1907, and 0·94 per cent. January, 1907. Chance plays a very big *rôle.* The first 3-hours shift gave 0·35 per cent. cases, and 9 fatal or dangerous in about 43,600 man-shifts; the second 3-hours shift (after 3 hours interval) gave 0·72 per cent. cases, and 4 dangerous or fatal, in the same number of man-shifts. The sum of cases for the six hours is 1·07 per cent. The percentage in 10,700 man-shifts of 8 hours is 0·62. Two 3-hour shifts with a 3-hours interval appears, then, to be almost doubly as risky as one 8-hours shift, because it doubles decompressions. The percentage of illness was 0·66, of death 0·0035, in 557,000 man-shifts, with a decompression rate of 15 minutes from + 29 to + 33 lbs.

As bubbles persist for a long time, and may act as starting-points for the formation of other bubbles, it is wise to give long intervals of time between successive shifts in deep-water work. Bubbles have been seen in veins of animals killed 48 hours after decompression (Bert, Haldane). They last for days in the spinal cord (Boycott and Damant), and in the subcutaneous fat of pigs.

Recompression of the Greatest Value.—Of the above 3,692 cases among 10,000 men, 89 per cent. were bends, 5 per cent. vertigo = 95 per cent. non-dangerous; 1·26 per cent. pain and prostration, 2·16 per cent. paralysis, 1·62 per cent. dyspnœa, 0·46 per cent. collapse = about 5 per cent. dangerous.

Recompression in the medical lock relieved 90 per cent., and of the rest all but 0·5 per cent. were partly relieved. Oxygen breathing could be used with great effect in the medical lock, and it ought to be always at hand there. Down Bros. make for me a small face-mask, by which the gas can be administered efficiently from a cylinder of compressed oxygen. The ordinary way of giving it to patients through an open funnel or nozzle is most inefficient.

Von Schrötter has suggested breathing hydrogen or marsh gas to dilute the oxygen and wash out the nitrogen—a dangerous mixture to use, and I cannot see how it will help, for these inert gases will be dissolved and take the place of the nitrogen.

Recompression is no good if delayed too long. Nerve cells, cut off from the bloodstream for a few minutes, cannot be recovered. Therefore the men should live close to the medical lock.

Fat in the Food.—The following observations made by F. Twort and myself show how water behaves when reduced from + 90 to + 20 lbs., and either left quiet or gently shaken.

WATER SHAKEN FOR 30 MINUTES AT + 90 LBS.

Dissolved Air found.	Dissolved Air at + 90 lbs. calculated.	Dissolved Air at + 20 lbs. calculated.	When collected.
15·1	15·71	—	at + 90 lbs.
14·9	15·28	—	at + 90 lbs.
14·42	15·88	5·26	at + 20 lbs.
9·26	15·28	5·06	after 2 hours at + 20 lbs.
9·78	15·74	5·16	after 2 hours at + 20 lbs.
8·26	16·35	5·41	after oscillation for 15′ at + 20 lbs.
10·47	15·73	5·21	after oscillation for 5′ at + 20 lbs.
6·07	16·19	5·36	after oscillation for 30′ at + 20 lbs.

On gentle oscillation the gas is given off without bubbling. Bubbles only occurred when the water was roughly shaken. This shows how stage decompression is safe as far as regards the watery part of the blood. Oil, on the other hand, bubbles when left quite at rest. It is probable that the fat in the blood, liver, etc., starts the bubbling, and fat eaten increases the

amount of this. Flatulence should be avoided. We lost six goats on one occasion—decompressed from +90 to +20, after a big meal of vegetables. They had chewed the cud at +90 lbs., and died from gaseous distension of the stomach.

Conclusion.—The practical conclusion of the above review is that while decompression times at caisson works are often too short, those tabled by the Admiralty Committee are unnecessarily long. Particularly is this so if the men be persuaded to exercise their bodies during decompression. While the evidence of the superiority of the stage over uniform method is not so marked as the Admiralty Committee maintained, I find a stage method can be made fairly safe, and is the best one to use for caissons.

I think that a stage at + 8 lbs. lasting 15 minutes is enough after a shift at + 30 lbs., and a stage of 30 minutes at + 15 lbs. after a shift at + 40 to 45 lbs., provided a medical lock for recompression is at hand. Five minutes in the first, and 10 minutes in the second case, should be given for completing the decompression. Von Schrötter recommends for +1 to 1½ atmospheres a shift of 6 to 8 hours and decompression in 10 minutes, quicker at first; for + 2 atmospheres a shift of 6 to 8 hours decompression to + 0·8 atmospheres in 3 minutes, and then to + 0 at rate of 4 minutes per 0·1 atmosphere; for + 3 atmospheres a 3 to 4-hours shift and decompression to +1·5 atmospheres in 3 minutes, and then to + 0 at rate of 4 minutes per 0·1 atmosphere. If the men can be arranged to climb from top to bottom of the shaft during the stage it will greatly increase their safety. The breathing of oxygen from a Fleuss apparatus for five minutes immediately before decompression would act in the same way, and, if this were combined with exercise at the stage, the time of decompression might be safely shortened. By how much, further experiment will show. Fat and the older heavy-built men must be excluded, and all men with a defective circulation or pulmonary ventilation. A preliminary trial of "green" men at short shifts is perhaps advisable (Keays). It ought to diminish the tendency to bubble formation if fat food were avoided by caisson workmen, and the diet limited to lean meat, bread and potatoes.

DISCUSSION.

Mr. E. H. Tabor, in opening the discussion, said that any engineer practically engaged in carrying out works in which the use of compressed air was necessary must feel greatly indebted to the author and those associated with him for the valuable researches they had conducted. The only point to which he wished to allude was the beneficial influence of exercise during decompression. As all engineers knew, it was very difficult to arrange in practical work that the men who were being decompressed should exercise while in the air-lock, which was universally a very small chamber where there was not much room to do any work. Moreover, when the men had done their spell of work in the caisson, they did not want to do any more when they got into the air-lock. Some time ago the author informed him that Mr. Bornstein had found it was beneficial if the men did work after they came out from the compressed-air chamber. He thereupon tried the experiment in some works with which he was connected, and the result proved that a good deal was to be said for the system. Figures given by engineers were not comparable with those given by scientists, as it was difficult in practical engineering work to obtain comparable conditions, but the following results were obtained, which he thought were of great interest. Among the men who did not do work after they came out of the air-lock and had been decompressed, there were thirty-seven slight cases of illness in seven weeks. When the men were made to climb a staircase or ladder about sixty feet high after being decompressed, there were only nine cases of slight illness in four weeks. During the first period there was one case of illness in every ninety-four decompressions, and in the second period only one case in every 240 decompressions; and, as far as he was aware, the other conditions were not more favourable during the first period than they were during the second.

Mr. Leon Gaster inquired how many hours the author thought it was advisable that a man should work under compressed air. Special records were kept in Holland of the number of accidents that occurred during compressed-air work, and he was given to understand that two and a half times as many accidents took place when the men were working eight hours at a stretch as when they worked for two periods of four hours, with an eight hours rest in between. It would also be of interest to know what medical supervision was employed for the purpose of selecting men for compressed-air work, and what medical supervision was employed during the actual work.

The Chairman (Mr. E. W. Moir) said that for the past twenty years he had been associated with compressed-air work, and quite recently in connection with the four tunnels made under the East River he was called upon to advise the Bureau of Labour of New York State in reference to the hours of labour, and the general conditions he suggested should be adopted for compressed-air working. The recommendations he made were contained in the appendix to his remarks. Those recommendations were not adopted, but eventually a rough

combination of what he suggested and what the working-men's union desired was put into practice. It was not a very scientific arrangement, but it was a vast improvement on anything that had previously been adopted. Twenty years ago, when he first went out to America in connection with compressed-air undertakings, the death-rate was 25 per cent. per annum of the men employed during the construction of the works, and having his own life to look after, he did all he could to ameliorate the conditions. From the experience he obtained in the erection of the Forth Bridge, prior to that time, on the effect of recompression on the men there employed, he conceived the idea that, whatever might be the cause, recompression was certainly the cure of the trouble. Accordingly, he built the first recompression lock, and he was greatly surprised at the markedly beneficial results which were obtained. His old chief at the time, Mr. Pearson (now Lord Cowdray), was paralysed when he came out of the Hudson Tunnel, in which he had been for two and a half hours, and he was cured of his paralysis within thirty-five minutes by recompression and very slow decompression. He had known a man cured of paralysis twice within five hours. Engineers owed a deep debt of gratitude to the author and his associates for the tremendous amount of unselfish work they had put into their experiments. Engineers had fumbled along, and had arrived at certain conclusions in a rough-hewn kind of way, one of which, with regard to the effect of stage decompression, conflicted, he was sorry to say, with the author's view. It had always been found that if the workmen passed through two or three air-locks, the benefits were very great from a health point of view; why, he did not know. Engineers always put in another diaphragm, if possible, and had at least two air-locks working, as a result of which it was always found there were fewer cases of caisson disease. Prior, therefore, to Dr. Haldane's theoretic discovery, engineers had recognised the benefits of stage decompression, although they did not know the cause. The first diaphragm of the old Hudson Tunnel was so leaky that a second had to be constructed, and that was the first occasion on which two diaphragms were put in operation. It was forced upon their notice that more cases of bends occurred when only one air-lock was in use than when there were two. Whenever possible, more than one air-lock was now built; and recently in the East River Tunnels, where work was being done up to a pressure of 40 lbs. per square inch, which was decidedly a deadly limit, there was not a single serious case of caisson disease experienced. The men took forty-eight minutes to get out, passing through three locks, including two periods of ten minutes of exercise so strongly advocated by the author. Prior to that, with only one lock at a less pressure, several deaths occurred. If decompression was continuously going on, it was difficult to arrange for exercise, but if the men were decompressed in stages it was automatic. If a man had to walk a thousand feet in order to get out, he must perform a certain amount of exercise. The more intelligent men generally worked their muscles and arms in the air-locks, and there was no doubt that that exercise tended to eliminate the bubbles of gas, which were the cause of the trouble. Personally, he did not agree with the author's opinion that carbonic acid had no serious effect. He knew of a case where, after a caisson had been sunk and finally closed in at the bottom with concrete, without any caisson disease occurring, trouble had developed in a few days, and, in fact, seven deaths occurred out of eight men, although precisely the same pressure was used, the only difference being that the air-compressors were run very much more slowly, because there was not leakage and the air-locks were not working. Whether the CO_2 allowed the nitrogen to get into the more delicate parts of the anatomy, or whether by being more easily absorbed, and therefore more rapidly given out, it produced the first block in the system he could not say; but he was confident, as it was only a matter of pounds, shillings and pence to get down the CO_2, it was much better to keep it low. Possibly it was merely an index of something else which caused the trouble. The most interesting details given in the paper proved that if caterpillars could only be trained, they were the ideal caisson-workers, and that pigs were not; and the fact that the author survived the terribly high pressures to which he subjected himself in the course of his experiments proved that he was not a pig. In conclusion, it gave him the greatest possible pleasure to propose a cordial vote of thanks to Dr. Hill for his most valuable paper.

The resolution of thanks was then put and carried unanimously.

Dr. Leonard Hill, in reply, stated that the questions asked by Mr. Gaster were fully answered in a portion of the paper which he had been unable to read owing to the limitations of time. In reply to the Chairman's remarks with regard to CO_2, he thought that no evidence had yet been obtained as to whether the trouble was caused by CO_2, or by heat. If the ventilation was diminished, worse results were obtained; and bad ventilation not only meant more CO_2 but an entire alteration in the cooling of the body. The Chairman contended that it was the CO_2 which did the damage, while personally he thought it was the over-heating and the cooling of the body; and the question in dispute could only be determined by exact experimental observation. With regard to stage decompression, it would be found at the end of the paper that the method he recommended was the stage method. The only thing he objected to was the rather exaggerated way in which that method was regarded by the Admiralty Committee. While he did not think it was so infinitely better, he agreed that the stage method, plus exercise, and plus, if possible, oxygen, was the best method of all.

APPENDIX TO THE CHAIRMAN'S REMARKS.

RECOMMENDATIONS MADE TO THE COMMISSIONER OF LABOUR FOR NEW YORK STATE IN REGARD TO REGULATIONS AND NECESSARY PRECAUTIONS TO BE TAKEN TO ENSURE THE SAFETY AND HEALTH OF EMPLOYEES WORKING IN COMPRESSED AIR.

Hours of Labour.

Eight-hour shifts at the tunnel face in up to 32 lbs. per square inch gauge pressure, with half an hour off for a meal about mid-time, outside in the open-air, if only one diaphragm and one lock; if there be two diaphragms, the meal to be taken between locks, where the pressure will be about half-face pressure.

Above 32 lbs. per square inch gauge pressure, 6 hours in 24 hours in two 3-hour shifts at face, with 2 to 3 hours between working time outside in the ordinary air, in a dry warmed house.

Above 42 lbs. gauge pressure, 2 shifts of 2 hours each at face with 2 to 4 hours' spell between in the ordinary air, in a dry warmed house.

Every man to be medically examined and passed before entry, and periodically thereafter, and also after prolonged absence from work.

Men are to be held answerable if they neglect to carry out rules.

Hot coffee is to be supplied to men at each exit.

Warmed drying-rooms and washing up rooms to be provided for all compressed-air workers.

A recompression medical lock to be provided on all works where the maximum pressure is above 20 lbs. per square inch gauge pressure.

Duration of Decompression.

Gauge Pressure. (Per square inch.)	For One Diaphragm and Lock.		For Two Diaphragms and Two Locks. (For pressures over 25 lbs. per square inch.)
15 lbs.	1 to 3 minutes.		With five minutes between diaphragms at about half maximum gauge pressure.
20 "	3 to 4 "		
25 "	6 to 8 "		3 to 4 minutes.
30 "	12 to 15 "		6 to 8 "
35 "	15 to 20 "	With 10 minutes between locks.	8 to 10 "
40 "	25 to 30 "		12 to 15 "
45 "	35 to 40 "	With 15 to 20 minutes between each lock if 2, and 10 to 15 minutes if 3 locks.	18 to 22 "

RULES ADOPTED AND MADE LAW IN THE STATE OF NEW YORK.

The New York State Legislature have brought forward an Act, signed by the Governor, and taking effect January 1st, 1910, controlling the hours of labours and rates of decompression.

The hours of labour are regulated as per the following table:—

Gauge Pressure (in lbs.).	Time under Pressure.	Interval between Spells.	Uniform Decompression. (minutes.)
0–28	8 hours less interval	30 consecutive minutes spent in the open air	18⅔
28-35·99	2 spells of 3 hours each	At least 1 hour	24
36-41·99	2 spells of 2 hours each	At least 2 hours	42
42-45·99	2 spells of 1½ hours each	At least 3 hours	46
46-49·99	2 spells of 1 hour each	4 hours	50

and no employee shall be permitted to work in pressures exceeding 50 lbs. per square inch, except in cases of emergency.

The decompression shall be at the rate of 3 lbs. every 2 minutes, unless the pressure shall be over 36 lbs., in which event the decompression shall be at the rate of 1 lb. per minute.

EXPERIMENTS WITH BLOOD.

Some rough but interesting experiments were made on animal blood with the following results:—

1. A syphon bottle with a gauge attached was partly filled with bullock's blood, and filled with compressed air at 36 lbs. gauge pressure, and was rotated for 24 hours under this pressure. The pressure was suddenly released, and no visible bubbles showed themselves. Upon closing the valve, however, and letting the syphon stand an hour, a gauge pressure of 1 lb. to the square inch was registered, and at the end of 6 days a pressure of 13 lbs. on the square inch was recorded, showing:—

First, that saturation may never have risen to the full pressure, and

Second, that desaturation progressed very slowly indeed, and much more slowly than it is supposed to do in the body.

2. The vessel was again charged with compressed air up to 100 lbs. pressure, and the entire vessel was then kept rotating slowly for a period of 14 hours. At the end of this time the valve was opened, remaining open 5 minutes, and all the air let out of the vessel without any apparent foaming or surging of the blood. Upon closing the valve and allowing the vessel to stand undisturbed, a continuous decompression was observed, ranging over a period of 3 weeks, indicated by a rise of pressure in the syphon. At the

end of the first week the gauge showed a pressure of 12½ lbs.; at the end of the second week the pressure stood at 25 lbs.; and at the end of the third week the pressure had risen to 31 lbs., where it remained, showing that after the first rapid decompression a slow decompression of the air contained in the blood had taken place until the pressure reached approximately one-third of the original pressure imposed on this vessel. Just what this final pressure would be would, of course, depend on the amount of blood saturated and the amount of space above for the air to expand into.

From my own experience and that of many of my staff, I am confident that after continued daily entering a chamber under compressed air, the blood does not desaturate for more than one week. I have felt it passing through my own veins over my shin bones after my return to England from New York on a periodical visit.

In conclusion, and to confirm the practical results already achieved, slow decompression will largely eliminate troubles in caisson works, and it is confirmed in my experience, and has been for years, that stage decompression is more effective than a continuous gradual fall in pressure, and it is fortunate that this method, due to the use of more than one air-lock and diaphragm, in tunnels at least, is the one most likely to arise in practice. In deep caissons for bridge work, however, it is not nearly so easy to apply.

HOME INDUSTRIES.

Steamships and Safety.—Attention was recently directed in these Notes to the supply of boats on large passenger steamers, and it was pointed out that the law as it stands is inadequate to the legitimate requirements of the travelling public. Since then more than one large passenger steamer has been reported lost, and the list of these lost vessels is becoming a long one. It does not of course follow that because a steamer leaves port and is never heard of again blame properly attaches to anyone. A derelict, or a sunken rock, may send a ship to the bottom and leave no trace of the disaster. Or she may turn over in a heavy gale and go down. The Board of Trade inquiry upon the loss of the "Waratah" has arrived at the conclusion that this is what happened to that vessel, but there is a growing opinion that ships are less safe than they used to be, and that the Board of Trade Regulations imperfectly protect the passenger. Take the case of the "Waratah." It was alleged by many witnesses at the inquiry, and was the opinion of many persons who had travelled in her but were not called, that she was top-heavy. The Court has rejected that view, and it must therefore be assumed that it is not warranted by the facts. But it will not be disputed that the "Waratah," like many of the other new passenger ships, was in appearance—at least in the eyes of the layman, if not of the seaman—top-heavy, and that of late years construction has taken the shape of deck upon deck in a way that would have been considered dangerous in other days. It may be said that the Board of Trade Inspector would not pass a ship whose stability was not assured, but the President of the Board of Trade has recently admitted that he lacks the necessary powers for effective intervention. Again, upon the question of boats. The theory of the Board of Trade is that every vessel should carry enough boats to take off the whole of the passengers and crew she is authorised to carry. Is that done? Take a mammoth liner with passengers and crew amounting to 2,000 or 3,000 souls. At most she would not have more than sixteen life-boats, carrying, say, sixty each, or in all under 1,000. There is no regulation of the Board of Trade requiring a vessel to carry more than this number, a number that would have been enough twenty years ago, when the regulation was passed, but is very far from adequate as regards the larger liners of to-day. It will be said that in addition to her life-boats, the vessel may have collapsible boats and rafts, but sailors have no faith in these auxiliaries. It is urged again by builders that nowadays the great liner is so built as to be unsinkable, and therefore the question of the sufficiency of boats ceases to be important so far as they are concerned. But it has yet to be proved that any vessel on the water is unsinkable, whilst it is known that a few months ago one of these "unsinkable" steamers went down so quickly that there was hardly time to get out the boats. It is true that although the maximum number of boats required by the regulations is admittedly insufficient for the very large liners now running, the Board of Trade officials insist upon certain additions being made to the boat accommodation over and above the maximum named in the regulations, but this at best is not a satisfactory substitute for the specific requirements of the regulations. Again, owing to the fierce stress of competition, the stowage of steamers is much less carefully attended to than it used to be, with the result that the steamer often goes to sea in a condition that almost invites disaster. The shipowners do their best to fulfil all legitimate and reasonable requirements, but they have many interests to consider—not least the demand of the travelling public for luxurious accommodation never dreamed of in other times—and many of them would welcome a Board of Trade inquiry into the three crucial matters referred to in this Note: (1) construction; (2) boats; (3) stowage.

Mill Loans and Income-Tax.—An interview has been arranged between certain Lancashire members and the Chancellor of the Exchequer on the subject of the reclaiming of income-tax on the interest paid by spinning mills on their loan capital. These loans are often used as a way of investing small savings, so that a mill's loans may be in a great number of amounts of £50 or £100. In inviting these loans, 4 per cent. interest has been promised, free of income-tax. But the money thus paid has in the regular course paid tax, which has been

reclaimed by those whose incomes were low enough to give them the right to reclaim. The Board of Inland Revenue recently decided that in future these claims for repayment will not be allowed, but representations from the representatives of those interested have induced the Board so far to modify the position they have taken up as to sanction the continuance of those claims in respect of interest paid for periods ending not later than September 30th next, the object of the concession being to give spinning companies time to make fresh arrangements with their lenders. It is understood that the Board hold strongly that the claims are not justified by the strict letter of the law.

Wood-Pulp as a Textile Material.—The possibilities of wood-pulp as a textile material have been brought to the front by Mr. Herbert Partington's statement. In Germany and the United States "paper yarn" has long since passed the experimental stage. At first regarded as a mere curiosity, it was quickly found that yarn could be manufactured from wood fibre more cheaply than from shoddy or cotton waste. The cellulose is cut into flat strips of varying width and thickness, and spun on specially-constructed machines, either alone or with the addition of a fine cotton thread. The cloth is strong, flexible, and serviceable, and does not ignite easily. It also takes dyes well. Tapestries, curtains, carpets, druggets, towellings, laces, and cellular underclothing are amongst the products manufactured from the new yarn. Mr. Partington mentions a mill in the Midlands which is spinning some 2,000 tons of pulp-yarn yearly, and one mill in Saxony which was recently turning out twenty tons a day. In Saxony the labour cost of producing one kilo (2·2 lbs.) of the yarn is about a third of a penny.

The Outlook for Rubber.—There has been a steady rise in the price of rubber during the last week or two, and the facts would seem to point to the maintenance of high prices. At a meeting of one of the leading rubber companies, held a few days ago, the chairman gave some interesting figures as to the statistical position. Taking 300 lbs. per acre as a fair estimate of the average production throughout the Middle East, and the present area under cultivated rubber at approximately about 730,000 acres, divided roughly into 370,000 acres in the Malay States, 180,000 acres in Ceylon, 130,000 acres in Java and Sumatra, and 50,000 acres in South India, Borneo, etc., he pointed out that this acreage, if properly kept up, is capable of producing, when in full bearing, about 100,000 tons of rubber per annum. But of course this maximum would not be reached, since it implies the highest possible cultivation and first-rate management throughout. Last year there was got from the Middle East about 8,000 tons of rubber. This year, Mr. Lampard estimates the available supply at 15,000 tons of rubber; next year about 25,000 tons, in 1913 about 45,000 tons, in 1914 about 70,000 tons, and in 1915 about 100,000 tons. Mr. Lampard's estimate of the consumption for 1909-10 is 100,000 tons, of which South America supplied 40,000 tons, the Middle East 8,000 tons, and the remainder of the world 52,000 tons. The ratio of increase in the consumption of rubber during the last few years has exceeded 10 per cent., and basing the calculation on this, and taking the world's consumption to-day at 100,000 tons, in 1912 the world will require 110,000 tons, in 1913 121,000 tons, in 1914 133,000 tons, and in 1915 146,000 tons, and the proportion of this amount possible to be produced by the Middle East Mr. Lampard puts at 100,000 tons in 1915. It will probably be a good deal less, but assuming that it amounts to 100,000 tons, there will still be a very large amount of rubber required by the world. It seems, then, safe to assume that high prices for rubber will be maintained for some years to come, and it must be remembered that if the price fell temporarily, it would at once check the supply of the wild collected rubber, and the price would then automatically rise again. If Mr. Lampard is right, cultivated rubber can be produced at a very much lower price in the Middle East than that at which it can be collected outside of it.

Brewery Stocks. — The investing public seem inclined to think better of the debentures and preference-stocks of English brewery companies than they have done for some time past. Notwithstanding a tendency to inflation, the securities of these companies, when first offered to the public, were viewed with favour, and they became a favourite form of security. For the most part, and for many years, the dividends paid confirmed the good opinion originally entertained. Then came a change, due to several causes. Unwise competition among the brewery companies for the acquisition of licensed properties led to heavy losses. A gradual change in the drinking habits of the community did not improve matters, and fears of legislative interference with the industry, culminating in a proposal that all licences should revert to the State in an average period of 11½ years, intensified the uneasiness of investors. It is true that this proposal did not become law, but the imposition of heavy licence duties was the alternative, and there was the fear of further legislation inimical to the brewing interest. This fear has now been lessened by the promise of the Chancellor of the Exchequer that in the new Finance Bill allowances will be made for the reduction in assessable value, and that assessment value shall be the basis of future taxation. The result is a rise in brewery stocks, and in some instances these debenture stocks stood at a large discount. Considerable purchases have been made on behalf of the companies concerned, with a view to improving the general position of the undertaking by the extinction of such debentures. The rise in quotations for brewery debenture stocks and preference shares which has occurred this year ranges from ½ per cent. to 8 per cent., and the buying appears to be of an investment character. The debenture stocks of

leading brewery companies are amply secured, and the present rise in this description of brewery securities is in most cases justified, for the fall had gone too far, but investors will do well to remember that the brewery companies have still to reckon with a shrinkage in the demand for their products, and the possibility of further hostile legislation.

CORRESPONDENCE.

MODERN MACHINE BOOKBINDING.

In my paper on "Modern Machine Bookbinding" (published in the *Journal of the Royal Society of Arts* for February 17th) machines were described for practically all operations in commercial bookbinding, with the exception of those of glueing the back and applying the back-lining of mull and paper. I had a note of a patent for a machine adapted for these purposes, but as I was unable to learn whether or not the machine was actually on the market I did not refer to it. I have since definitely ascertained that several of these machines are working in American binderies. The machine is known as the Blauvelt Supering, Head-banding, and Back-lining Machine; it consists of a series of small machines, over which is a rotary carrier in which are assembled fourteen pairs of jaws for holding books. After a book has been fed to a pair of jaws, it is brought to the first glueing machine where the first coat of glue is applied to the back of the book; the book is then moved round to the super [*i.e.*, mull] apparatus, where the super is fed the proper width, cut to size, and applied to the back; it then passes round to the second glueing machine, where a second coat of glue is applied over the super; it is then carried to the head-banding machine, where the head-band is automatically made, cut to size, and attached to the book; it is subsequently brought to the paper-lining machine, where the paper-lining is pasted, cut to size and applied to the back, and finally the book is returned to the operator, who removes it. The machine is estimated to work at the rate of fourteen books per minute.

GEO. A. STEPHEN.

GENERAL NOTES.

THE POLYTECHNIC.—The Polytechnic, Regent-street, founded by Quintin Hogg in 1882, is being rebuilt at a cost of £90,000. The rebuilding fund was inaugurated by a grant of £20,000 from the London County Council, and a loan of £20,000 from the City Parochial Foundation. The £50,000 needed to complete the fund has been subscribed and promised by Lord Leith of Fyvie, the Governors, members and students of the Polytechnic, and other friends intimately associated with the institution, as a memorial to King Edward VII. The Polytechnic is one of the more important centres for the Society's examinations, presenting an average of about 350 candidates.

INTERNATIONAL CONGRESS OF THE APPLICATIONS OF ELECTRICITY, TURIN, 1911.—This Congress will be held at Turin from September 9th to 20th, under the auspices of the Italian Electrotechnical Association. The Committee have drawn up a list of over thirty subjects for discussion, which appears to be very exhaustive. It is hoped that the meetings will be strongly international in character, as the official delegates of the Electrotechnical Committees of various nations will be in Turin at the time, attending the first meeting of the International Electrotechnical Committee of Standardisation. Papers may be written in French, or in English, German, or Italian, when accompanied by a translation or summary in French, and all these languages will be admitted in the discussions. Persons wishing to offer papers or to learn further particulars of the Congress should communicate with the Secretary of the Committee of Organisation, Via S. Paolo 10, Milan.

FORESTRY IN BRITISH COLUMBIA.—The report recently published by the British Columbia Forestry Commission, which was appointed in 1909, is the first attempt at a systematic stocktaking of timber resources of Canada. It is estimated that British Columbia grows half the merchantable timber of the Dominion, its forest area being fifteen million acres, capable of yielding, under present methods of work, nearly two hundred billion feet super of timber. Of this area nine million acres are held under a special licence system. Options to cut timber during a twenty-one-year period on specified square miles of forest are granted, but at the same time the Provincial Government retains an effective control by reserving the right to fix from year to year the annual payments in rental and royalty to be made for the renewal of these options, and they also impose a reserve upon all remaining Crown timber. The Commission are of opinion that the demand for timber will raise the value of the British Columbian forests to heights now considered incredible, and that, with careful management, these resources should permanently relieve the people of the province from serious taxation.

NEW MEXICAN RUBBER PLANTS.—A resident in Mexico, who has for some years been experimenting in rubber-producing plants, has discovered, in the district of Manzanillo, a tree, a vine, and three plants which yield, according to the American Consul there, a first-class rubber. The tree is of quick growth, and can be propagated from slips put in the ground. Limbs that were thrown in the shade and left for six months germinated, and on being planted took root and are now growing well. Trees planted from slips will be large enough to prune in three years; limbs cut from the trees furnish the rubber; pruning can be done every year. This tree produces about 6 per cent. crude rubber. The three plants referred to grow wild,

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FRIDAY, MARCH 10, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

Members are requested to take notice that the Ordinary Meeting on Wednesday, March 15th, will be held at **4.30 p.m.**, instead of 8 o'clock.

MONDAY, MARCH 13th, 8 p.m. (Cantor Lecture.) Professor J. A. FLEMING, M.A., D.Sc., F.R.S., "Applications of Electric Heating." (Lecture II.)

WEDNESDAY, MARCH 15th, **4.30 p.m.** (Ordinary Meeting.) Colonel CHARLES EDWARD CASSAL, V.D., F.I.C., "The Adulteration of Food." The Right Hon. the LORD MAYOR OF LONDON will preside.

THURSDAY, MARCH 16th, 4.30 p.m. (Indian Section.) CLAUDE HAMILTON ARCHER HILL, I.C.S., C.S.I., C.I.E., "Education in India." The Right Hon. Lord NORTHCOTE, G.C.M.G., G.C.I.E., will preside.

CANTOR LECTURE.

On Monday Evening, March 6th, Professor J. A. FLEMING, M.A., D.Sc., F.R.S., delivered the first lecture of his course on "Applications of Electric Heating."

The lectures will be published in the *Journal* during the summer recess.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1911 early in May next, and they therefore invite members of the Society to forward to the Secretary on or before Saturday, April 1st, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great services to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Michael Faraday, D.C.L., F.R.S., "for discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, etc., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I., "for services rendered to Arts, Manufactures, and Commerce by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in

aiding the establishment and development of International Exhibitions, the Department of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (afterwards Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvements in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential services in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power — hydraulically — due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious manual labour."

In 1879, to Sir William Thomson (afterwards Lord Kelvin), O.M., LL.D., D.C.L., F.R.S., "on account of the signal service rendered to Arts, Manufactures, and Commerce by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science to industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labour in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silkworms and domestic animals, whereby the arts of wine-making, silk production, and agriculture have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and as Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate knowledge of the floras and economic vegetable products of our several colonies and dependencies of the Empire."

In 1884, to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communications of North America, and have thereby rendered valuable aid to the commerce of the world."

In 1885, to Mr. (afterwards Sir) Henry Doulton, "in recognition of the impulse given by him to the production of artistic pottery in this country."

In 1886, to Samuel Cunliffe Lister (afterwards Lord Masham), "for the services he has rendered to the textile industries, especially by the substitution of mechanical wool combing for hand combing, and by the introduction and development of a new industry—the utilisation of waste silk."

In 1887, to Her Majesty Queen Victoria, "in commemoration of the progress of Arts, Manufactures, and Commerce throughout the Empire during the fifty years of her reign."

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S., "in recognition of the value of his researches in various branches of science, and of their practical results upon music, painting, and the useful arts."

In 1889, to John Percy, LL.D., F.R.S., "for his achievements in promoting the Arts, Manufactures, and Commerce through the world-wide influence which his researches and writings have had upon the progress of the science and practice of metallurgy."

In 1890, to Dr. (afterwards Sir) William Henry Perkin, F.R.S., "for his discovery of the method of obtaining colouring matter from coal tar—a discovery which led to the establishment of a new and important industry, and to the utilisation of large quantities of a previously worthless material."

In 1891, to Sir Frederick Abel, Bart., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S., "in recognition of the manner in which he has promoted several important classes of the Arts and Manufactures, by the application of Chemical Science, and especially by his researches in the manufacture of iron and of steel; and also in acknowledgment of the great

services he has rendered to the State in the provision of improved war material, and as Chemist to the War Department."

In 1892, to Thomas Alva Edison, "in recognition of the merits of his numerous and valuable inventions, especially his improvements in telegraphy, in telephony, and in electric lighting, and for his discovery of a means of reproducing vocal sounds by the phonograph."

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S., "for their joint services to scientific agriculture, and notably for the researches which, throughout a period of fifty years, have been carried on by them at the Experimental Farm, Rothamsted."

In 1894, to Sir Joseph (afterwards Lord) Lister, F.R.S., "for the discovery and establishment of the antiseptic method of treating wounds and injuries, by which not only has the art of surgery been greatly promoted, and human life saved in all parts of the world, but extensive industries have been created for the supply of materials required for carrying the treatment into effect."

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S., "in recognition of the services he has rendered to Arts, Manufactures, and Commerce by his metallurgical researches and the resulting development of the iron and steel industries."

In 1896, to Professor David Edward Hughes, F.R.S., "in recognition of the services he has rendered to Arts, Manufactures, and Commerce by his numerous inventions in electricity and magnetism, especially the printing telegraph and the microphone."

In 1897, to George James Symons, F.R.S., "for the services he has rendered to the United Kingdom by affording to engineers engaged in the water-supply and the sewerage of towns a trustworthy basis for their work, by establishing and carrying on during nearly forty years systematic observations (now at over 3,000 stations) of the rainfall of the British Isles, and by recording, tabulating, and graphically indicating the results of these observations in the annual volumes published by himself."

In 1898, to Professor Robert Wilhelm Bunsen, M.D., For. Memb. R.S., "in recognition of his numerous and most valuable applications of Chemistry and Physics to the Arts and to Manufactures."

In 1899, to Sir William Crookes, F.R.S., "for his extensive and laborious researches in chemistry and in physics—researches which have, in many instances, developed into useful practical applications in the Arts and Manufactures."

In 1900, to Henry Wilde, F.R.S., "for the discovery and practical demonstration of the indefinite increase of the magnetic and electric forces from quantities indefinitely small—a discovery now used in all dynamo machines—and for its application to the production of the electric searchlight, and to the electro-deposition of metals from their solutions."

In 1901, to His Majesty King Edward VII., "in recognition of the aid rendered by His Majesty to Arts, Manufactures, and Commerce during thirty-eight years' Presidency of the Society of Arts, by undertaking the direction of important exhibitions in this country, and the executive control of British representation at International Exhibitions abroad, and also by many other services to the cause of British Industry."

In 1902, to Professor Alexander Graham Bell, "for his invention of the telephone."

In 1903, to Sir Charles Augustus Hartley, K.C.M.G., "in recognition of his services, extending over forty-four years, as Engineer to the International Commission of the Danube, which have resulted in the opening up of the navigation of that river to ships of all nations, and of his similar services, extending over twenty years, as British Commissioner on the International Technical Commission of the Suez Canal."

In 1904, to Walter Crane, "in recognition of the services he has rendered to Art and Industry by awakening popular interest in Decorative Art and Craftsmanship, and by promoting the recognition of English Art in the form most material to the commercial prosperity of the country."

In 1905, to Lord Rayleigh, O.M., D.C.L., Sc.D., F.R.S., "in recognition of the influence which his researches, directed to the increase of scientific knowledge, have had upon industrial progress, by facilitating, amongst other scientific applications, the provision of accurate electrical standards, the production of improved lenses, and the development of apparatus for sound signalling at sea."

In 1906, to Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S., "for the important part he took in the invention of the incandescent electric lamp, and for his invention of the carbon process of photographic printing."

In 1907, to the Earl of Cromer, G.C.B., O.M., G.C.M.G., K.C.S.I., C.I.E., "in recognition of his pre-eminent public services in Egypt, where he has imparted security to the relations of this country with the East, has established justice, restored order and prosperity, and, by the initiation of great works, has opened up new fields for enterprise."

In 1908, to Sir James Dewar, M.A., D.Sc., LL.D., F.R.S., "for his investigations into the liquefaction of gases and the properties of matter at low temperatures—investigations which have resulted in the production of the lowest temperatures yet reached, the use of vacuum vessels for thermal isolation, and the application of cooled charcoal to the separation of gaseous mixtures and to the production of high vacua."

In 1909, to Sir Andrew Noble, K.C.B., D.Sc., D.C.L., F.R.S., "in recognition of his long-continued and valuable researches into the nature and action of explosives, which have resulted in the great development and improvement of modern ordnance."

In 1910, to Madame Curie, "for the discovery of radium."

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A Meeting of the Colonial Section was held on Tuesday, February 28th, the Right Hon. LEWIS HARCOURT, M.P., Secretary of State for the Colonies, presiding.

Lord BLYTH, Chairman of the Colonial Section, announced that letters had been received from the Duke of Abercorn, the Earl of Selborne, Lord Curzon of Kedleston, Lord Ampthill, and many other gentlemen, regretting their inability to attend the meeting from various causes.

The CHAIRMAN said he had stolen an uncovenated hour from the House of Commons because he could not resist the temptation of the invitation offered to him to attend the meeting, and the treat which he knew he should enjoy in the paper which was to be read. He was happily aware that none of those present had attended for the purpose of listening to the platitudes or the prosing of a politician, and, therefore, his own part in the proceedings would be very brief. He was told on arriving at the meeting that it was part of his duty to introduce the author, Sir Richard Solomon. He proposed to do nothing of the sort. He could not imagine anything more ludicrously inappropriate than that he should have the temerity to attempt to introduce a gentleman whose name was a household word in two continents, a gentleman whose services were fully recognised in England—services which he had rendered to the great Union of South Africa by his life, by his residence in the country, and by the work which he was happily continuing in the position he now occupied in London. No such introduction could be necessary, and as he was quite certain that the audience was anxious to hear the information which the author was so fully and admirably fitted to convey, he would at once call upon him to read his paper.

The Paper read was—

THE RESOURCES AND PROBLEMS OF THE UNION OF SOUTH AFRICA.

By the Hon. Sir RICHARD SOLOMON, K.C.B., K.C.M.G., K.C.V.O., K.C.,

High Commissioner for the Union of South Africa.

The Union of South Africa embraces an area of 420,000 square miles, or twice the size of France. It has, according to the last census, taken in 1904, a European population of about 1,120,000 and a coloured population of over 4,000,000, of whom approximately 3½ millions are pure aboriginal natives in different stages of civilisation.

It is based on a written constitution embodied in the South Africa Act passed by the Imperial Parliament in 1909, under which the self-governing colonies of the Cape of Good Hope, Natal, Transvaal, and Orange Free State, were brought into a legislative Union under the Crown with one Government and one Parliament, each of these colonies becoming a province of the Union.

It is with the resources and problems of the Union that this paper attempts to deal. I shall not make any reference to the native protectorates, now under the direct control of the Crown, nor to Southern Rhodesia, under the administration of the British South Africa Company, beyond expressing the general opinion that, in course of time, all these territories will be included in the Union of South Africa, which will then comprise the whole of British Africa south of the Zambesi.

Within the time at my disposal this afternoon I cannot attempt to make anything like an exhaustive survey of the resources of the Union, nor of the future problems which lie before it. All I can venture to do is to give some general idea of its wealth as a producing country, and of the difficulties of some of the problems which its Government and Parliament have to solve in the near future.

It is unnecessary to say much about the mineral resources of the Union. They have for years past attracted much public attention in this country, more especially the mines in the Witwatersrand district of the Transvaal, which produce 95 per cent. of the gold exported from the Union of South Africa. Sixty miles of reef within this district are now actually being worked. Discovered in 1886, they differ from gold-bearing reefs in other parts of the world in the consistency of the sedimentary deposits and the extraordinarily even distribution of the gold; so that, to quote from an article by Mr. Lionel Phillips, one of the leaders of the mining industry, which appeared in a special edition of the *Times*, published on the day of the opening of the first Parliament of the Union by H.R.H. the Duke of Connaught, "large sums of money can be invested with confidence in opening up mines on a large scale and equipping them with extensive appliances which would not be justifiable in quartz mines. The Witwatersrand reefs are poor in yield compared with those in some other gold-producing countries. They average about 29*s*. per ton, while in the reefs in Australia and New Zealand the yield varies from 55*s*. to 140*s*. per ton; in India from 38*s*. 6*d*. to 108*s*., and in the United States from 127*s*. 9*d*. to 200*s*. But, nevertheless, as a field for the investment

of capital, the Witwatersrand mines are unrivalled because of the reliability of the deposits."

Another characteristic of gold-mining in the Transvaal is mentioned by Mr. Phillips in the same article. The temperature of the earth downwards varies in different parts of the world, but the normal rise is about one degree for every sixty-five feet of vertical depth. In the Witwatersrand district the temperature only rises at the rate of one degree for every 255 feet. It is, therefore, probable that mining will be carried on to a much greater depth in the Witwatersrand mines than anywhere else in the world.

Since 1887, when the Witwatersrand district of the Transvaal first commenced to produce gold, to the end of 1909, the value of the precious metal produced by the Transvaal was £258,000,000. In 1887 the output was only 0·78 per cent. of that of the whole world; it is now about one-third of it. The total dividends distributed by the gold-mining companies in the Transvaal during the year 1910 amounted to £9,118,858.

Next in importance to gold in the way of minerals in South Africa are diamonds. South Africa is the only place in the world where diamond mines or pipes, going vertically downwards to an unknown depth, have ever been discovered. In Brazil, which, before the discovery of mines in South Africa, was the only producer of diamonds, no mine or pipe has ever been found. The precious stones were found in gravel beds, which were only of a small depth and have now been practically worked out. At present within the Union of South Africa there are diamond mines in Kimberley, in the Orange Free State, and in the Transvaal. The value of the diamonds produced since their discovery in 1870 is about £133,000,000. The supply, as far as we can see, is inexhaustible, and any demand can be met; but the world can only take a limited quantity per annum, and the output is, therefore, controlled as far as possible so as not to glut the market and reduce the value of this precious stone.

Besides gold and diamonds, South Africa is rich in base minerals. Coal is found in every province of the Union sufficient for all its requirements. During the year 1910 the Union imported about 66,000 tons of the value of £37,000, while it exported 1,475,000 tons of the value of £991,000. From this it will be seen that practically the whole of the coal used by the gold-mines and diamond-mines, by 7,000 miles of railways, by all the other industrial undertakings in South Africa, as well as for domestic purposes, is supplied from collieries within the Union; while at the same time an export trade in that mineral is being developed. At present the value of the coal produced within the Union is nearly £2,000,000 a year, and the Government take in railway rates on its transport about £100,000 a month. Natal alone, where coal-mining may be described as the principal industrial asset, produced in 1909 about 1,750,000 tons. Natal coal will, in all probability, find a permanent market in India and Ceylon. The locomotive superintendent of one of the great railways in India, after visiting the South African coal-fields, reported that Natal coal was from 8 to 10 per cent. better than the bulk of Bengal coal, and advised the placing of substantial orders for the former; last year one of the Natal collieries secured a contract for 5,500 tons of coal for the Ceylon Government Railways.

Copper is also produced within the Union, principally by the mines in Namaqualand, the total output of which up to the end of 1909 was of the value of £7,500,000. Other copper-mines, such as the Messina, near the Limpopo, are being developed in other parts of the Union, while the exploitation of a number of tin properties in the Waterberg district of the Transvaal gives encouragement to the view that in the near future tin will be a substantial export of the Union. Iron is found in large quantities in South Africa, and a company has now been formed and will shortly start operations in the Transvaal for the main purpose of converting scrap-iron, of which an immense quantity has collected, into steel, but which will also experiment on the iron ore of the country.

The discovery of minerals has brought about a great change over the face of South Africa, and has played an important part in its history and in the development of its resources generally. The gold and diamond mining industries have furnished the inducement and the capital for the construction of railways, harbours, and other public works. They have given vitality to the coal-mining industry, and have enabled the Government to incur large expenditure for the benefit of agriculture, the permanent industry of South Africa.

Up to 1870, when the diamond mines in Kimberley were discovered, the only railway lines which existed in the whole of South Africa south of the Zambesi were a line of fifty-seven miles from Cape Town to Wellington, opened for public traffic in 1863, a short line of eight

miles from Salt River to Wynberg, and a line two miles long from Durban to the Point. To-day, owing to the development of the diamond-mining industry in Kimberley, and of the gold mines in the Transvaal especially, there are within the Union 7,045 miles of railway in use and 900 miles in actual construction. The South African Railways to-day is one of the largest centralised railway undertakings in the world.

I have no desire to weary you with a mass of figures, but the following will be interesting. The capital spent on harbours and railways within the Union amounts to £89,000,000, of which £11,600,000 were paid out of their revenues, leaving £77,400,000 as representing the loan capital of the Railways and Harbours Administration, on which that Administration pays the Government of the Union interest at the rate of 3½ per cent., the Government being responsible for the payment of that debt, which forms part of the total debt of the Union, estimated at £116,037,000. Under the Constitution of the Union of South Africa, after the expiration of four years the income derived from railways and harbours will be expended solely on them, and will not be available for ordinary expenditure. The railways are to be administered by a Board of Commissioners appointed by the Governor-General in Council "on business principles, due regard being had to the agricultural and industrial development of the Union, and the promotion by means of cheap transport of the settlement of an agricultural and industrial population in the inland portions of the Union."

According to the financial statement of the Minister of Railways during the present session of Parliament, the gross revenue from railways and harbours for the year ending March 31st, 1910, was over £1,000,000 per month.

In 1873, about two years after the discovery of diamonds in Griqualand West, but before that discovery had had time to produce any substantial effect on the prosperity of South Africa, the number of passengers carried on the railways was 436,000 in round numbers, while in 1909 it was 15,350,000; the goods traffic in the former year was 66,000 tons, while in the latter year it was 1,350,000 tons. In 1873 the net earnings of the railways in South Africa were £65,700, while in 1909 the earnings of the railways in the Union alone, after payment of working costs and interest on capital, amounted to £3,129,000. These figures show what railways have done for the development of South Africa, and what an important factor they have been in a country in which there are no navigable rivers or deep estuaries. They are the only means of communication between the ports and the interior, for the day of the ox-waggon has passed away.

In salaries and wages the gold mines in the Witwatersrand district alone paid over £11,000,000 during the year 1909, and I do not think it is an exaggeration to say that the wages earned annually by native miners within the Union amount to quite £5,000,000, which is practically all spent in the different districts in which they reside. "It will perhaps be realised, therefore," says a writer on the subject of native labour in South Africa, "what prospects there are in the development of trade and commerce with the natives. The extent to which our commercial prosperity in South Africa depends on the well-being and success of the native labourer is scarcely realised. Thirty years ago the great majority of aboriginal natives did not work at all. To-day, owing to the mines, the majority of them spend half the time between the ages of twenty and forty in intermittent periods of work. Unfortunately, the labour statistics of the country are very imperfectly kept, but there are probably at present nearly 750,000 natives working for European employers within the Union." The gold-mines in the Transvaal alone employ about 200,000, the diamond-mines about 42,000, the coal-mines about 20,000, and about 19,000 are employed on the railways and harbours. When it is remembered that the total native population in Africa south of the Zambesi is about 7,000,000, of whom there are probably not more than 1,400,000 males over the age of sixteen capable of doing work, it can hardly be said with any justification that the natives are a lazy people. The desire for work is steadily though slowly increasing. Economic and social causes are undoubtedly tending to make the native more of a continuous labourer than he is at present, but it is difficult to predict how long the transformation will take.

The effect of the gold-mines on native life is not entirely a happy one. The death-rate is, unfortunately, still high. The last Government returns issued show an actual death-rate of thirty-three to the thousand, and this leaves out of account those who contract miners' phthisis and go home and die. The conditions on the mines are, however, improving, and the increase from 142,000 native labourers in 1904 to 200,000 to-day is largely due to that improvement.

The whole system of recruiting has been revolutionised, and labour agents are controlled by legislation in each province. The conditions under which the natives travel to the mines have been greatly ameliorated. Rest houses have been established on the road, and better railway accommodation provided. The rations supplied have been improved and varied, and a Government director of labour has been appointed with a staff of over 100 inspectors, interpreters, medical officers, and clerks for the supervision and control of natives, inquiring into their complaints and exercising a general supervision over their comfort and welfare. Magistrates from the Transkeian territories and other recruiting areas personally visit the mines and inquire into the complaints of native labourers, and are thus able to explain to the natives in their territories from personal experience the actual conditions under which the native miners work and live. The result is that, whereas in 1906 there were only 2,600 natives from the Cape province employed on the Rand mines, in 1910 there were 80,000.

For the year 1909 the Transvaal gold-mines spent £10,000,000 in round numbers on material, machinery, and explosives, of which articles producible in South Africa, such as explosives, candles, cement, etc., amounted to £4,000,000. These figures give some idea of the importance of the mines in the Transvaal to both British and South African producers and manufacturers.

For the year 1910 the value of the oversea imports into the Union, excluding specie, was about £34,000,000 in round numbers, and that of the oversea exports about £52,000,000, including gold and diamonds. In 1873 the imports into Cape Colony and Natal together amounted to only £2,800,000, and the exports from the two colonies together were valued at £2,900,000. I have not the figures for the Transvaal and Orange Free State, but the imports into and exports from those two States would not be anything like as large as in the case of Cape Colony, so that it is quite safe to say that in 1873 the imports into the four colonies and states now forming the Union, did not exceed £4,000,000 a year, and the exports from them oversea must have been considerably less. In other words, it may be said that the present trade of the Union is at least ten times as great as was the combined trade of the colonies and states now included in it, about the time when the diamond-mining industry was first established.

While the history of the material progress of South Africa during the last forty years has been substantially a history of the discovery and development of its minerals, I venture to think that an era of great agricultural prosperity has now commenced, and that before many years have passed South Africa will be looked upon, not only as a rich mineral country, but as one of the principal agricultural countries of the world.

The progress made during the last few years has been remarkable. The advantages of scientific farming, of adopting the most modern methods of cultivation, and of dealing with diseases of animals and pests are being fully appreciated.

The establishment of land banks, agricultural schools, and experimental farms; the encouragement and assistance given to co-operative associations and agricultural societies; the equipment of the Government Agricultural Department with the best experts it is possible to obtain, to advise farmers on the treatment of animal diseases, and the proper cultivation of the soil, are only instances of the efforts which are being made by the Government for the development of the agricultural resources of the country. These efforts, initiated by Lord Milner's Crown Colony Administration in the Transvaal, are strongly supported by Parliament, which votes over £700,000 a year for that purpose.

There was a time when South Africa imported nearly all its foodstuffs, and though it still imports many articles which can and ought to be grown and manufactured locally, everyone is sanguine that, within a few years, not only will the Union be self-supporting, but it will be a substantial exporter of food. If we take the year 1906 as the first year after the war when the commercial, agricultural, and mining industries had settled down to normal conditions, and were no longer appreciably affected by the war, we find that the total agricultural exports from the four colonies now forming the Union of South Africa were £6,145,000 in value, while in 1910 they amounted to £10,750,000, or an increase in four years of about 75 per cent.

Again, comparing the imports for 1906 with those of 1910, it will be found that while the total value of the imports, excluding specie, had increased by nearly £4,000,000, the amount of foodstuffs imported in the former year into the four colonies now forming the Union amounted to £7,770,000 in value, while the amount imported in 1910 had fallen to £5,900,000, showing that the products of South Africa had replaced a quantity of foodstuffs which had been previously imported.

Wool is the most important of all the agricultural exports from the Union. In 1826 the value of the quantity exported from South Africa was only £545. In 1841 it reached £200,000. Rapid progress was made from year to year, though in some years there was a set-back owing to droughts, diseases among sheep, and other causes. Some time elapsed after the war before the farmers in South Africa could replenish their flocks, but they are doing so now with great success. The country is well stocked with sheep of a good class, thousands of thoroughbred animals are being imported from France and Australia, and very high prices are being paid for good stud rams.

The value of the wool exported from the Union of South Africa during last year was £3,831,000. The Government has, through its experts in South Africa and the Trade Department in London, done much to instruct the farmers in the clipping, sorting, and baling of their wool for the home market, with the result that considerable improvements have been effected in the "get up" of South African wool.

The Angora goat is one of the successes of the Cape farmer, and the value of Angora hair exported from the Cape province of the Union in 1910 was £903,000. I believe I am right in saying that the only other country which produces mohair is Turkey, and though Cape mohair may be inferior to the finest quality exported from that country, it more than makes up by its larger output. The South African Angora goat has now a great reputation, and its exportation oversea is prohibited by law.

Cattle-breeding is another great agricultural industry in South Africa, and notwithstanding the fact that the country was almost denuded of cattle during the war, and has had since to contend against the ravages of East Coast fever—which is now being steadily stamped out by the persistent and scientific efforts of the Government, loyally supported by Parliament—the number of horned cattle within the Union is probably more than 4,000,000. A few years ago a large quantity of frozen meat was imported into South Africa owing to the dearth of cattle. To-day South Africa can supply all its own requirements in meat, and will, in the near future, be an exporter of it. Co-operative creameries have been established, with the result that, in the Orange Free State alone, the amount of butter made has increased from eight tons in 1905 to 1,000 tons, of the value of £125,000, in 1910. These creameries have given a great impetus to cattle-breeding, and South Africa may fairly look forward to becoming a substantial exporter of butter.

Efforts have been made since the war to establish a distinct breed of South African horse, but that object has not yet been attained. The late Transvaal and Orange Free State Governments maintained a stud of from twenty to thirty horse sires, mainly thoroughbred, which were leased to farmers at reasonable prices. About twenty years ago the Cape Government imported a number of hackney sires, which were sold out of hand on arrival and distributed through the country. South African conditions favour the production of the mounted infantry type, which is really the South African horse, and horses suitable for mounted infantry find a ready sale at about £25 each. Horse-breeding is now extensively carried on in different parts of the Union.

One of the most important agricultural industries in the Union, judged from the present value of its exports, is ostrich farming. Statistics show that in 1826 feathers to the value of £2,800 were exported, consisting almost entirely of what was plucked from the wild ostrich after killing it. The industry has for years past been pursued in a much more intelligent manner, and the farmers engaged in it realised long ago the difference in value between inferior and superior feathers, and different strains of birds were bred, which are known by the names of well-known ostrich breeders.

The ostrich feather industry is surrounded by many problems, and the Trade Department in London of the Union Government must be constantly on its guard to advise farmers of any changes in fashion, and must also keep a sharp eye on the supply and demand of the markets in connection with special classes of feathers.

The principal ostrich-breeding districts within the Union are in the Cape Province. The total quantity of feathers exported in 1910 was of the value of £2,273,000, which were almost all sold on the London market. As in the case of the Angora goat, the exportation oversea of the ostrich and also the ostrich egg is prohibited by law.

During the last fifteen years strenuous efforts have been made to develop an export trade in fresh fruit from South Africa, which have met with considerable success.

In the year 1900 the total quantity of fruit exported in ships' cold storage amounted to 17,336 boxes. Ten years later it exceeded 200,000 boxes, the total value of which was

about £35,000. The principal fruits now exported from the Union are grapes, plums, peaches, nectarines, apricots, and pears. The export of citrus fruit, comprising chiefly oranges and naartjes (mandarines) is increasing rapidly, and may be said to have passed the experimental stage. Oranges are grown in all the Provinces of the Union. They arrive in the London market at a time of the year when there are no supplies from other parts of the world, and excellent prices are obtained for them.

Experiments, under Government auspices, are still carried on with a view to ascertaining the best methods of packing and transportation. The policy of the Government is not to subsidise the fruit export trade by cash contributions, but to help the producers as much as possible by means of advice, through the Agricultural Department of the Union and the Trades Commissioner in London, as to the best methods of cultivation, the best types of fruit, picking, packing, and the precise requirements of the oversea markets.

In the cultivation of maize (known in South Africa as mealies) lies one of South Africa's greatest potentialities. It is the staple crop of a large part of each of the Provinces of the Union, and, besides being excellent as food for human beings, may be used for starch, glucose, animal food, and spirits. Under the most helpful guidance of the Government, the export of maize is increasing yearly. It has grown from 41,400 tons, of the value of £184,000, in 1907 to 160,000 tons, of the value of £700,000, in 1910, of which 43 per cent. was shipped to the United Kingdom, 29 per cent. to Belgium and Holland through Antwerp, and 27 per cent. to Germany through Hamburg.

As a field for maize cultivation, South Africa is unrivalled, and the industry offers great attractions to cultivators with energy and enterprise. The climate is ideal, with an ample rainfall in the summer months during the growth of the grain, and a dry winter for harvesting it. No country in the world can produce a finer quality of maize. The corn trade speak in no uncertain way of their preference for South African maize to that of other countries.

The world's annual consumption of this product is at present over 90 million tons, the British market alone absorbing over two million tons a year. The opportunities for expansion are unlimited, and the Union of South Africa may be relied upon in the future to contribute a large portion of this colossal trade.

Maize, however, is not the only cereal which can be successfully grown in South Africa. Oats have for many years past been produced in large quantities, more especially in the Cape Province, and an increasing quantity is being exported to the British market. Wheat is also grown in certain parts of the Union, but in the past has suffered somewhat from the ravages of rust. It is confidently hoped that the investigations which are being made by the expert agriculturists of South Africa will result in the production of a wheat which will overcome this difficulty. When this is accomplished, there is no reason why South Africa should not, within a comparatively short time, be able not only to satisfy its own demands, but also to export to other countries. Barley, Kaffir corn (a kind of Indian millet), and many other descriptions of produce are grown in South Africa owing to the richness of its soil and the variety of its climate. In fact, almost every known cereal can be produced.

While farming in South Africa has many advantages, such as a healthy climate, a productive soil, and cheap labour, it must be admitted that it is subject to many disadvantages, in the way chiefly of droughts, diseases of animals, and insect pests. The advantages, however, counterbalance the disadvantages, and, as a rule, a man with average ability and energy, possessed of a moderate capital, who applies himself judiciously to farming pursuits for a period of from five to ten years, should by the end of that time not only have a comfortable income derived from the cultivation of his land, but the capital value of his holding and of his stock should become increased to a marked degree.

In addition to what I have already mentioned, there are other South African products which form a substantial part of the export trade of the Union. The black wattle, introduced from Australia, yields a high percentage of tannin, which is used in the tannage of leather, and is now extensively grown in Natal. There are at present about 200,000 acres under cultivation, giving a return of 24,000 tons of bark. The value of the quantity at present exported is nearly £200,000 per annum, almost the whole of which goes to the Continent of Europe, as English tanneries do not yet consider it to be of sufficient regular quantity and supply to warrant them putting down plant to deal with it.

Transvaal tobacco has a high reputation among smokers in South Africa, and efforts

are now being made to produce a superior leaf. The Government of the Union have imported American experts and have established experimental stations and large tobacco warehouses, where the leaf grown by the farmers will be treated by the latest and best methods, and afterwards sold to manufacturers in the open market. The production of tobacco is rapidly increasing, improvement both in its cultivation and treatment is most marked, and the future prospects of the industry are very bright.

Cotton-growing is quite a new industry, although, during the last four or five years, a number of farmers in the Zoutpansberg District of the Transvaal have been growing this crop in a small way. Last season experiments were made in growing cotton at Tzaneen, Rustenberg, and Barberton, and the results obtained surprised the most sanguine expectations; for the crops from American seed were disposed of in the Liverpool market at prices varying from one penny to twopence per pound higher than that paid for American upland varieties. The normal Transvaal season is specially suited to cotton-growing, as the rainy period from October to April is of sufficient duration for the full growth and development of the plant, while the crop can be harvested during the dry season from May to August. The largest cotton belt in the Transvaal lies in the Zoutpansberg District, and the railway now being built, which will unite Pietersburg with Delagoa Bay, will open up a large and suitable region for this industry.

Cotton-growing has also been cultivated in parts of the Cape Province, and a company has already been formed to take up land on the coast between East London and St. John's River for that purpose. It is said that that part of the country is in every way, both as regards soil and climate, excellent for cotton-growing.

Forty or fifty thousand acres in Natal are under sugar-cane, and manufactories have been established there for years. The annual production of sugar is about 74,000 tons, while the quantity required for the whole of South Africa is a little over 100,000 tons, so that about 25,000 tons are imported. It is a highly protected industry, as not only is imported sugar subject to a Customs duty of five shillings per 100 lb., but Natal sugar has preferential railway rates for its conveyance. Over four thousand acres in Natal are under tea cultivation, the production of which during 1910 was about 800 tons, nearly the whole of which was consumed locally.

Viticulture is one of the oldest South African industries. Established first in the days of the early Dutch settlers, it has become a most important factor in the development of the western districts. It maintains something like 80,000 people. In 1909 (the last year for which I have the figures) about 3½ million gallons of wine were produced, and there is no doubt of the great improvement in recent years, especially in the light wines made at the Cape.

Lord Blyth, an eminent authority on viticulture, was asked by the late Government of the Cape Colony, two years ago, to visit South Africa and report to them on the prospects of this industry. In his most valuable memorandum on the subject, he states his opinion that natural wines, both white and red, can be produced in many localities of the Cape Province of a sufficiently good quality to satisfy the wants of a large proportion of the wine-drinking population of the Union, and that there is also a fair prospect of a limited quantity of wines of the port wine type being exported to other parts of the world. Lord Blyth, however, does not appear at all sanguine of any great export trade in Cape wine being developed, and is evidently of opinion that the wine farmers in the Cape Colony should look to their own market as the substantial outlet for the bulk of the wine produced in South Africa, and should give more attention to the cultivation of grapes for export as fresh fruit and as raisins, for which there is an ever-increasing demand in every part of the world.

I have dealt at such length with the resources of the Union that I am afraid I have left myself very little time to discuss some of its problems.

Many questions relating to the constitution of the Legislature, such as plural voting, equality of votes, redistribution of seats, the powers of the Upper Chamber of Parliament, and the settlement of conflicts between it and the Lower Chamber, which are still the subjects of controversy in this country, have fortunately been settled for the Union of South Africa in its written Constitution, under which effect is given to the principle of one man one vote, and one vote one value, by providing for one-member electoral divisions, each containing, as far as possible, with due regard to density or sparsity of population, physical boundaries, etc., the same number of registered voters. The automatic increase of the number of members of the House of Assembly assigned to each Province, in proportion to the increase in its number of electors, is based on certain definite rules, thus avoiding any necessity in the future of introducing into the Legislature such a contentious measure as a Redistribution of Seats Bill.

The Senate or Upper House of the Legislature, one-fifth of whose members were nominated by the Governor-General in Council, and four-fifths were elected by the Parliaments of the Colonies (now Provinces) prior to their dissolution on the taking effect of the Union, has all the powers of legislation enjoyed by the Lower, or popularly elected House, except in respect of a money bill, which it can neither originate nor amend, though it may reject it. Provision is made in the Constitution for settling a conflict between the two Houses in respect of a Bill passed by the Assembly, by a joint sitting of their members. The Bill passed at such sitting becomes law.

The settlement of these important matters in the Constitution itself is of the greatest importance; it avoids the conflicts and the unsatisfactory compromises which would inevitably have taken place had such matters been left to the decision of Parliament.

It must be admitted, however, that there are questions of first-class importance for which only a makeshift solution has been provided in the Constitution, and to which the attention of the Parliament of the Union must in the near future be given. Among them is the question of the parliamentary franchise. In a Legislative Union, the qualification for an elector ought to be the same throughout. This is not so, however, in the Union of South Africa, for, under its Constitution, owing to circumstances which could not be avoided, the qualification for a parliamentary voter in a province remains what it was before union was established, and differs materially from that in the adjoining province. Whether uniformity will be created by adopting for the whole of the Union, as far as the European population is concerned, adult male franchise, which exists in the Transvaal and Orange Free State, or a property franchise, which exists in the Cape of Good Hope and Natal, I do not attempt to predict. Much may be said in favour of both; but as, by the adoption of the latter, many persons in the Transvaal and Orange Free State will become disfranchised, it is not improbable that there will be a strong feeling in favour of giving every adult European male throughout the Union the parliamentary vote. A more difficult question arises in respect of the admission of coloured persons to the franchise, from which they are at present excluded in the provinces of the Transvaal and Orange Free State, and practically in Natal. In the Cape of Good Hope, however, no distinction was ever made between Europeans and coloured persons in this respect. The qualification for the parliamentary franchise in that colony was prescribed by law, and whoever possessed it became entitled, without distinction of race or colour, to be registered as a voter. The South African Constitution not only continues this law, but provides that, though the Parliament of the Union may in future prescribe by statute the qualification which shall be necessary to entitle persons to vote at the election of members of the House of Assembly, yet no such law shall disqualify any person in the province of the Cape of Good Hope now entitled to the franchise, by reason of his race or colour only, unless it was passed at a joint sitting of the members of both Houses of Parliament, and at its third reading was agreed to by not less than two-thirds of the total number of members of both Houses.

I shall not speculate on what action is likely to be taken, in respect of this important question, by the Parliament of the Union of South Africa. Uniformity in native policy was one of the reasons for the union of the self-governing colonies, but it cannot be brought about in a hurry. It is difficult, however, to see how South Africa can go backwards on this question, and produce uniformity by depriving the coloured persons of the Cape of Good Hope of privileges which they have enjoyed for more than half a century, and which they have, on the whole, exercised wisely.

One of the most exacting tasks of the Government and Parliament of the Union will be the settlement of its Civil Service, consisting now of the staffs of four different administrations. A commission has been appointed, in terms of the Constitution, to make recommendations not only for such reorganisation and readjustment of the departments of the Public Service as may be necessary, but also in regard to the assignment of officers to the several provincial administrations. Upon receipt of this report, the Governor-General in Council will assign to each province such officers as may be necessary for the proper discharge of the services reserved or delegated to it. In addition to this temporary commission, appointed for a special purpose, the Governor-General in Council is authorised and required by the Constitution to appoint a permanent Public Service Commission, with such powers and duties relating to the appointment, discipline, retirement, and superannuation of public officers, as Parliament shall determine. It is confidently anticipated that the result of the appointment of these two commissions will be the

establishment of an efficient Civil Service, with security of tenure, pensions, and promotion, and, above all, absolutely independent of the favours of political parties.

The amalgamation into one legislative Union of four self-governing colonies, in which different laws, even on matters of common concern to the whole of South Africa, were developed, means a vast amount of work in establishing anything like legislative uniformity. The process must be slow, but there ought to be no delay in establishing uniformity in the different laws which now prevail on such important subjects as taxation, the solemnisation of marriages, patents, trade-marks, joint-stock companies, and commercial documents such as bills of exchange and promissory notes. Already notice has been given by the Minister of Finance of his intention to introduce legislation providing a uniform profits tax on the output of gold, diamonds, and base metals throughout the Union, which must shortly be followed by legislation introducing uniformity into the various laws which now prevail in the different provinces, prescribing the right of the State to a share in such portion of private land as may be discovered to be mineralised.

The Union Parliament will before long be called upon to fix a Customs tariff for goods imported into the Union. Since 1893 there have been Customs conventions between the different British South African States, formed for that purpose into a Customs Union. Under these conventions a uniform Customs tariff has prevailed throughout the Customs Union in respect of articles imported from outside, with a rebate on goods and articles the growth, produce, or manufacture of the United Kingdom. In most classes of goods this rebate at present amounts to 3 per cent. ad valorem. A similar rebate is given on goods and articles the growth, produce, or manufacture of any British Colony, Protectorate, or Possession, granting equivalent reciprocal privileges to the South African Colonies and territories, parties to the Customs convention. The advantage of this Customs arrangement between the different British South African States was that the duties on goods imported from outside the Customs Union into any one of them were paid at the ports, and there was no necessity, therefore, for erecting Customs houses on the boundaries separating the different States. Prior to the union of the self-governing colonies, there was no authority which could legislate for the whole of South Africa; the uniform tariff which has hitherto prevailed in its different colonies was settled from time to time at conferences of delegates from each of them, and submitted to their Parliaments for ratification. No amendment could be made in the tariff submitted; it had to be either accepted *in toto* or rejected. The different Parliaments concerned, anxious not to bring about fiscal confusion in South Africa by rejecting such a tariff, always accepted it, though strongly urging various objections to its different items.

The tariff settled at the last conference of delegates, held in 1906, though still in force, was objected to by each of the colonies on different grounds. A Conference of the Governments of the South African States was held in Pretoria in May, 1908, for the purpose of reconciling these differences as far as possible. The complete failure of the Conference in its object caused the first practical step to be taken towards the union of the South African Colonies by the passing of this resolution:—"In the opinion of this Conference, the best interests and permanent prosperity of South Africa can only be secured by an early union of the South African Colonies under the Crown of Great Britain."

It will be the duty now of the Union Parliament to settle a Customs tariff for goods imported into the Union from outside. The difficulties involved in such a settlement are great, and I will not attempt to make any forecast even of the main principles on which such a tariff will be based. There will undoubtedly be differences of opinion, among the members of the Union Parliament, on such questions as protective duties and rebates on British manufactured goods. A Commission has already been appointed by the Government to make inquiry into the industries of South Africa, and to recommend what support they should receive in the way of protection or bonuses. Addressing the South African Manufacturers' Congress, recently held in Cape Town, General Botha is reported to have said: "I can assure you that the fostering and developing of South African industries have the fullest sympathy of the Government, and I can assure you, further, that in cases where it can be proved that protection will lead to *bona fide* industries and not to unnecessary burdens on the country, your Association may depend upon support from the Government."

No doubt there are differences of opinion as to the advisability of continuing the existing Customs rebate on British manufactured goods, which involves a direct loss in Customs duties

to the Colonial revenue of over £500,000 a year. There are, however, other considerations of an Imperial character to which the Parliament of the Union will give due weight when dealing with this important question. For the year ending December 31st, 1910, the value of the total imports into the Union from oversea was about £34,000,000, of which 58 per cent. in value was imported from the United Kingdom, and 12 per cent. from British Colonies; 70 per cent., therefore, of the import trade of the Union, and about the same percentage of its export trade, is with the British Empire. South Africa is not a manufacturing country, and for that reason it offers greater opportunity to the British manufacturer than any other dominion of the Crown.

Some people talk as if the most serious danger to the prosperity of the Union of South Africa is the racial feeling between the English and Dutch people. I do not pretend to say that there is no such feeling to-day, but I have no hesitation in saying, that considering the conflicts of the past and the fact that a long and devastating war was only brought to a close ten years ago, with the loss to the burghers of the Transvaal and Orange Free State, and of the independence which they dearly loved, and for which they had gallantly fought, it is surprising to what extent that feeling has disappeared during the last three or four years. The conflicts between these races in ideals and aspirations were due, to a very large extent, to the fact that for political considerations, on which the people of South Africa were not consulted, that country became split up into parts not only under different administrations, but under different flags. No greater opportunity could have been given for the development of different systems and ideals. To-day, with all the different parts of South Africa, which were formerly self-governing, brought into a legislative union under the Crown, with equal political rights and equal rights of language symbolising absolute equality of the two races, with no shadow of pretence on the part of one race to be dominant over the other, there is surely no longer room nor justification for racial antagonism. The racial feeling will cure itself, and the less people talk and write about it, the sooner will that cure be effected.

The problem which overshadows all other problems in South Africa in difficulty and far-reaching effects is that which is generally expressed as the native question. I could take up the whole afternoon in discussing this problem from different points of view, but there is only time for me to point out some facts connected with it.

The European population within the Union of South Africa, the large majority of whom look upon South Africa as the permanent home for themselves and their children, does not exceed one and a quarter million, whilst the coloured population, largely scattered amongst the European, exceeds four million, consisting of different races in different stages of civilisation. About three and a half million are aboriginal natives, most of whom are still in a state of barbarism, but including a substantial and ever-increasing number of civilised men and women, among whom the demand for education is rapidly growing. Between the years 1894 and 1909 the number of coloured children at school has more than doubled itself, having increased from 80,000 to 170,000. In addition to the aboriginal natives, there are between 300,000 and 400,000 coloured persons with an infusion of white blood in their veins, living according to European methods, and whom the white man must always regard with sympathetic interest. A further addition to this mixture of races in South Africa are the Asiatics, numbering about 150,000, most of whom are British subjects, and whose presence in the country has given rise to questions of exceeding difficulty and delicacy, which are now receiving the earnest attention of the Government of the Union. The industrial fabric of South Africa is based on native labour, and there is not, therefore, the same demand for emigration from this country which exists in Canada and Australia. The number of skilled coloured workmen, of teachers, missionaries, and clerks, is daily increasing, causing a competition between them and Europeans which is one of the great difficulties of the situation. The problem with which South Africa is faced is what, in the interest of the country as a whole and in the interest of its different races, must be the relation between them socially, politically, and industrially. It presents itself in the framing of railway regulations, municipal bye-laws, in education, in the daily administrative work of the Government, and in the legislative work of Parliament. No one who has not lived in South Africa can appreciate the difficulties of this problem. Different views prevail as to the manner in which it should be solved, but no man living to-day can forecast its ultimate solution. A sound native policy must be slowly and naturally developed, and in that development

the only course, in my humble opinion, is to adhere to the good sound principles of justice and freedom and toleration. The action of the Union Government in the release of Dinizulu and of the other native chiefs banished to St. Helena under sentence for rebellion by courts-martial, as well as the repeal of Natal compulsory native labour law, are encouraging signs of the Government's attitude towards this problem.

The dual language makes the subject of elementary education an exceedingly difficult and delicate one. Unfortunately, the Constitution gives the control of it to the Provincial Administrations instead of to the Union Parliament. While the Education Acts of the Cape of Good Hope, Natal, and the Transvaal, on the whole, appear to satisfy both races, the English-speaking section of the European population of the Orange Free State have denounced the provisions of the Education Act of that province as unfair to the English language. I refrain from expressing any opinion on a matter on which, to a very large extent, the first election of members for the House of Assembly of the Union Parliament was fought. Early during the present session of that Parliament a resolution was brought forward condemning the Orange Free State Act as a violation of the provisions of the Constitution relating to equal language rights and opportunities. By an amendment to the resolution, moved by the Prime Minister and accepted by both parties, all the Education Acts of the provinces have been referred to a Select Committee of the House of Assembly, to report in what respects they should be amended so as to comply with the principles laid down in the Constitution. The Parliament of the Union itself has no jurisdiction to make any amendments which may be necessary for that purpose, but it is sincerely to be hoped that the Select Committee will bring forward such moderate and reasonable recommendations that each of the Provincial Councils will loyally accept them, and, if necessary, amend its Education Acts in such a way as to give no cause to either race to complain of injustice to its own language. Separate schools for English and Dutch children would, in my opinion, be a disaster of far-reaching effect. The fact that the children of both races now attend the same schools and grow up together will make the next generation of men and women free from racial feeling.

I have only time now to refer to one other problem, which must be dealt with by the Government and Parliament of the Union within the very near future, and that is the question of defence. The supremacy of the British Navy is essential to the safety of South Africa and to the protection of its oversea trade, situated as it is on one of the world's highways, with its long coast-line, with its territory marching on one side with that of the most powerful military Power in Europe, and on the other side with Portuguese territory; with an oversea trade of the value of nearly £100,000,000, the most important articles of export and import being included among those which, under the Declaration of London, are styled conditional contraband, liable to capture in neutral bottoms. More and more South Africans recognise their responsibility in helping to maintain the strength of the Navy. Before the Union the Colonies of the Cape of Good Hope and Natal contributed together an annual sum of £85,000 towards this object. That amount, which is being continued by the Union Government, will, no doubt, be considered as wholly inadequate. In criticising it, due weight ought to be given to the fact that the Union of South Africa practically contributes, in the shape of Customs rebates, over £500,000 a year to the support of British trade in South Africa. From the public speeches of responsible statesmen, there seems to be no prospect that the policy of small navies will be adopted, and South Africa's contribution to the naval defence of the Empire will probably take the form of an annual vote of money to the British Admiralty, in the amount of which due regard will be given to such expenditure as the Government of the Union may incur, with the approval of the Admiralty, in connection with local coast defences.

The Union of South Africa fully recognises its entire responsibility for its own local defence. It differs from the other self-governing dominions in having a serious native problem to deal with. When the native protectorates are brought within the Union, the Government will be responsible for the control of over five million natives, and it will be necessary to maintain local forces of sufficient strength to keep order therein. Excluding the police, the total strength of the militia and volunteer forces maintained by the four colonies which now form the Union is about 12,400, of which only about 670 are maintained on a permanent basis. The total strength of the mounted police is about 2,500, "a magnificent and well-mounted permanent force, receiving an amount of military training which varies in the different provinces. By force of circumstances, the police are necessarily

distributed in small detachments over wide areas of country, and it is impossible to collect them for any form of training to work together in large bodies; without such training they cannot be looked upon as a military force. They can, however, all ride and shoot, and are good horsemen."

In addition to the 12,400 local forces before-mentioned, there are also 11,000 members of rifle clubs, and about the same number of cadets under training, and an organised reserve volunteer force in the Transvaal of 1,000 men.

The forces at present available, excluding the British troops, which sooner or later will be removed, are quite inadequate to provide against the various requirements in connection with the defence of the Union. Though no scheme has yet been submitted to Parliament, the Prime Minister and Minister of Defence have both publicly announced the determination of the Government to raise a sufficient force to enable them to undertake responsibility for local defence, and have given some slight indication of their views as to the character of such a force. In a speech made just before the general elections, Mr. Smuts, the Minister of Defence, said: "Some people think we are going to have a great standing army. The people in this country do not want that. What they do want is a citizen army and a small striking force. In the second place, we shall require a permanent corps of instructors to train the citizens in their military duties." Universal service, already theoretically in force in Natal and the Cape of Good Hope, under the Defence Acts of those colonies, is foreshadowed in the political programme of the Nationalist or Government Party as follows:—"The establishment for South Africa, as a part of the Empire, of an adequate system of national defence, which will recognise the obligation of the citizen to take part in the defence of his country." In this connection it is important to note that the Minister of Defence has clearly explained in recent speeches that what is intended is some form of universal training. The system foreshadowed by him is, first, the encouragement of cadet corps in all schools, and, secondly, universal training during a certain period every year between the ages of eighteen and twenty-four.

In formulating a scheme for the submission to Parliament, the Government will have the advantage of the advice of Lord Methuen, who is taking the greatest interest in this question, and no doubt full consideration in any such scheme will be given to the plea put before the Imperial Defence Conference by the Army Council of similarity of organisation in all the defence forces of the Empire, so as to facilitate mutual support in times of emergency.

I am afraid this paper has extended to a greater length than is usual on these occasions. There are many other South African questions to which I should like to have referred, but time will not allow of it. I have been obliged, as it is, to give merely a sketch of a few problems which I thought might be interesting.

DISCUSSION.

The CHAIRMAN stated that he had immediately to return to his work in the House of Commons, but he could not do so without expressing, on behalf of the audience and himself, their gratitude for, and admiration of, the illuminating paper which the author had read. Lord Blyth had kindly consented to take the chair for the remainder of the meeting.

[The chair was then vacated by Mr. Harcourt, and taken by Lord Blyth.]

The Right Hon. Sir WALTER HELY HUTCHINSON, G.C.M.G., thought it would have been impossible for the Royal Society of Arts to have found a better guide, philosopher, and friend in their inquiries into the resources and problems of the Union of South Africa than his old friend, Sir Richard Solomon. Sir Richard was born and bred in the country; he was educated in South Africa until the years of adolescence, when he paid a visit to England, and at Cambridge succeeded in taking very high honours. He returned to South Africa, where he had a practical experience during many busy and strenuous years, and became a shining light in the learned profession which he adorned. He was the trusted legal adviser of one of the greatest corporations in South Africa during many years. After an excursion of some two or three years on the stormy sea of Cape politics, from which he emerged safe and sound, he became the not less trusted adviser of the Military Administrator of Pretoria after the war, and subsequently of the Crown Colony Government; he took his share in laying the foundation of the administration of the Transvaal, which now formed a part of the Union of South Africa; and, finally, he was now the chosen representative in England of the free Union Government of South Africa. He did not think it would have been possible to find a man better qualified to give an address on the resources and problems of the Union. The author had suffered under limitations of time and also of responsibility. No one knew better than he (the speaker) how difficult it was to draw up an illuminating address upon a subject which

interested not only the people whom one was addressing, but people at the other end of the world, who would always be ready to find fault with any slips, or expressions of opinion of which they did not approve. But Sir Richard had presented a clear and concise statement of the case; he had marshalled his facts with ability, and presented them in such a manner that they were easily understood; and he was sure the members of the Society were grateful to him for the pains he had taken, and for the success he had attained. It was, indeed, a remarkable story of progress, of development, and it contained great promise for the future. He had lived long enough in South Africa to have heard similar stories of progress and development. It had become almost proverbial, that in South Africa there was always "either a feast or a famine"—a period of boom, followed by a slump, and so on in alternation. He hoped that the story of promise which the author had narrated did not point to any extraordinary boom, but rather to peaceful advancement in the path of progress, which would gradually increase until South Africa became, as all who loved her hoped she would become, one of the brightest stars in the galaxy of Empire. There was only one statement in the paper that he desired to criticise — the statement that South Africa was not a manufacturing community. South Africa certainly was not a manufacturing country at present, but it did possess some manufactures. For instance, there was the manufacture of dynamite, of which article the Somerset West factory last year turned out no less than 370,000 cases; and there was also a large factory of dynamite near Durban, and another in the Transvaal. At the Durban factory the manufacture of glycerine from the whales which were caught on the coast of Natal had been commenced, and he had also heard that the enterprising Mr. Lever was laying down a great soap factory at Durban. He did not know whether beer could be called a manufacture, but a certain quantity of beer was produced in the country, and also wine, tea, sugar, matches, candles, and certain other things; but he admitted they were mostly produced in a small way, and always under protection. Nevertheless, it pointed to what might happen in the future; and when it was borne in mind that in South Africa there were millions of tons of iron ore lying close to the coal and to the limestone, only an adequate market and adequate labour and capital were required to start a manufacture of steel in South Africa which would take its place in the world. The whole thing, however, turned on the question of labour. That brought him to dwell upon the truth of what the author had said as to the vital importance to South Africa of the native question, which overshadowed all other questions in the country, whether on its economic, its political, or its social side. The author had mentioned that 200,000 natives were now working on the Rand; that a few years ago only 2,600 natives from Cape Colony were working at the mines, and now there were 80,000. That was true, and it was due to a certain extent to the improvement of methods of recruiting, in the accommodation for, and treatment of, the natives. It was also due to the fact that, just at the time when that large increase in native labour was required, there was a most terrible depression in South Africa. Natives were thrown out of employment at Kimberley by the thousand; the Governments ceased making railways; the ports did not do half the business they had done before, and all that helped to bring the natives to the Rand. Although there were 200,000 natives on the Rand at the present time, he was informed on good authority that 70,000 more natives were now required there. As a matter of fact, there were complaints of shortage of labour from all over the country. The Rand was not the only employer of labour. A great expansion was taking place in Rhodesia, and a further expansion must be expected now that the railway had reached the Congo State. The tea and sugar industries, and the coal industry, would now require more native labour, because of the stoppage of indentured coolie immigration. The demands for labour came from all quarters; and if, as the author anticipated, the agricultural interest in South Africa became, as he (the speaker) hoped it would become, one of the principal agricultural industries in the world, an enormous amount of labour would be necessary. In the matter of labour, South Africa might be said to suffer from a kind of auto-intoxication, of which the doctors spoke so much. A man might live well and grow fatter and stronger, but suddenly he felt ill and had to send for the doctor, who told him he was suffering from self-poisoning. In the same way, in South Africa, in times of depression labour became plentiful; the gold mines went ahead; the country progressed; people began to be better off; the Governments were richer and began to make railways; there was more trade in the ports; the farmers required more labour, and so the period of prosperity which was caused by the quantity of labour brought about scarcity of labour and checked prosperity. The economic side of the native question—the labour question—was one of the most important questions that would face the Union Government. He associated himself with all the author said about the relations between the Dutch and the British in South Africa. He noticed a telegram that day in one of the morning papers to the effect that an agreement had not been arrived at by a committee appointed to discuss the teaching of Dutch in the schools in South Africa, and that this might lead to the resignation of General Botha. He did not know whether it would lead to the resignation of General Botha—he did not believe it would; but whether it did or did not, the teaching of Dutch in the schools was relatively a minor question which would settle itself, and people in this country need not bother their heads about it. The people of South Africa had got to arrive at a settlement which would meet with the

general acquiescence of the whole of the people, and that settlement they would arrive at sooner or later. On that subject he felt as happy as possible, because he believed the two races would work together for the good of South Africa. They would derive from each other their best qualities, and in the end would evolve a type of which the nation as a whole might be proud.

Mr. P. J. HANNON said that the serious question of settling the preference to be given to British goods in the South African market would soon be brought up for discussion, and he hoped the author would use his influence to get the present preference on British goods continued, as it was a matter of great importance to the manufacturers of this country. The effect of that preference in favour of British produce enabled British manufacturers to get their goods into the South African market, and at the same time it helped labour in this country by providing employment. He hoped when the question came to be settled that the present preference would be retained in favour of the producers of this country.

The DUKE OF ARGYLL, K.T., in proposing a hearty vote of thanks to the author for his illuminating paper, said he was sure it had been an immense pleasure to the audience to hear a paper from a past-master in South African affairs, and he trusted it was not the last paper the Royal Society of Arts would have the benefit of hearing from the author on the subject. Sir Richard was thoroughly representative of the great communities in the union which had been effected, and it was very necessary that the people of this country should have instruction on South African affairs from instructors who really knew what they were talking about. Unfortunately, he had no personal acquaintance with South Africa, but he had been connected for a long time with a company which had to do with East Africa, and he was one of those who helped to push the British flag into Uganda. No one at the present time regretted that that had been done, although at the commencement of the operation there might have been a little difference of opinion on the subject. He spoke with greater freedom on that point since the Secretary of State for the Colonies had left the meeting. He must not, however, hark back upon that old controversy, except to say that he did not think anybody belonging to the present generation regretted that the British flag was now more or less dominant from the Nile to the Cape.

Sir DAVID GILL, K.C.B., F.R.S., in seconding the vote of thanks, said he could not plead, like his Grace, that he knew nothing of South Africa, for he had spent twenty-seven years of his life in that country. He could not, however, give any information as to what South Africa was like now, owing to the great and mighty political revolution that had taken place since he left there—a revolution which he trusted had been of the most beneficial kind for the future of that country and for the Empire. He could confirm, so far as his knowledge went, the accuracy of all the statements made by the author, and he was delighted to notice the hopeful and confident spirit which had characterised his remarks.

The CHAIRMAN (Lord Blyth), before putting the resolution to the meeting, said that many useful papers had been delivered in the hall of the Society, but he could not conceive of any paper being more useful and instructive to the whole of the people of the British Empire than the paper Sir Richard had delivered. It was interesting, not only to the people of the United Kingdom, but also to the people of the Overseas Dominions, and if publicity was given to it, he believed great good would result.

The resolution of thanks was then carried, and, Sir RICHARD SOLOMON having briefly acknowledged the compliment, the meeting terminated.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 8th, 1911; Sir SHIRLEY FORSTER MURPHY, F.R.C.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Barnes, Carl L., M.D., LL.B., 1977, Ogden-avenue, Chicago, Illinois, U.S.A.

Carroll, Alexander Ernest, Assoc.M.Inst.C.E., 7, Appion-way, Dublin, Ireland.

Crump, Colonel Malcolm Hart, Room 2, Elks Building, Bowling Green, Kentucky, U.S.A.

Darling, Charles Robert, Beechurst, 186, Eglinton-road, Plumstead, Kent.

Field, George Moyle Robert, M.Inst.C.E., 203, Coleherne-court, South Kensington, S.W.

Goldschmidt, Dr. Hans, 98, Bismarckstrasse, Essen-on-the-Ruhr, Germany.

Mason, Frank, M.Inst.M., 42, Birkendale-road, Upperthorpe, Sheffield.

Pitkin, Rev. John, Shapwick-cum-Ashcott, near Bridgwater, Somerset.

Wale, Charles, 8, Great George-street, Westminster, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Brichett, Dr. J. G., Cardwell, Missouri, U.S.A.

Bruck, Walter W., 64, High Holborn, W.C.

Converse, Edmund Cogswell, Conyers Manor, Greenwich, Connecticut, U.S.A., and 72, Broad-street, New York City, U.S.A.

Down, St. Vincent Bowen, Winchester House, Singapore, Straits Settlements.

Gladwell, Arthur, Brynmaur, Gerrard's Cross, Bucks.

Harvey, Ernest William, F.C.S., The British Empire Club, 12, St. James's-square, S.W.

Hastings, Percy, The Cottage, Wimbledon-common, S.W.

Moitry, Manmatha Nath, Serampore, Hoogli District, Bengal, India.

Williams, Stacy B., Brockweir, Urmston, near Manchester.

The CHAIRMAN, in introducing the reader of the paper, said the subject of plague was one that could not receive too much attention. The history of the past showed what it did years ago in this country, particularly in London. It had recently manifested its old virulence in other countries, and there had been reason for thinking seriously of it in the eastern counties of England. There was an excellent Government department dealing with the matter, and there was also a sanitary service, which did not exist in the old days; but it was of the greatest importance at the present time that the public should know what plague was and how it was caused. The author had a very ripe experience of the disease, having been in charge of the plague wards in the plague hospital of Hong-Kong during the outbreak of 1894; and he was intimately associated with the discovery of the plague bacillus at that time. He had had under his personal observation for a number of years, on behalf of the London County Council, every person who had in any way been suspected of suffering from plague, and it was due to his assistance that it was possible to say there had been no plague in the London community.

The paper read was—

PLAGUE AND ITS SPREAD.

By JAMES CANTLIE, M.A., M.B., C.M., D.P.H.

The prevalence of plague in the world in epidemic form since 1894 to the present moment—a period of sixteen years—is a matter of supreme interest and importance to the people of every nation. The question naturally arises at the moment: Has the virulence of the malady spent itself, and may we look forward to an abatement of the pandemic, and a hope that it may speedily disappear altogether? The history of previous epidemics does not engender a hopeful answer that it may do so; indeed, the opposite obtains, for all previous outbreaks indicate the long continuance of plague amongst every community in which it has gained a serious hold. Plague is also a slow travelling disease, for it took nine months to travel from the City of London to Soho in the seventeenth century. It is not a question of a prevalence for a few weeks or months or even years, but a continuance for several decades in any populous district where it has found a footing. In London, when plague last visited us in the seventeenth century, although the mortality was high for only a comparatively short time, local outbreaks occurred for a long period, and sporadic cases until the beginning of the eighteenth century. Judging even by the behaviour of the present epidemic, plague has lasted now for seventeen years in Southern China, and for fifteen years in India. Speedy disappearance of the disease from regions severely attacked is, therefore, not to be calculated upon—in fact, its long continuance is rather to be expected. It is this characteristic of plague which causes the disease to be dreaded as it is, for it is the only malady which prevails in epidemic form for a number of years in any given country.

The endemic home of plague amongst human beings is a matter of doubt. So far it is believed that plague is always present in the Indian Provinces of Kumaon and Ghurwal, on the southern slope of the Himalayas; but whether this is the only home of the disease, or whether there is, in addition, another in Mongolia, and yet another in East Africa, is not known. It may be that in no part of the earth is plague endemic amongst men, but that the disease is kept alive only amongst certain animals, and now and again in the history of the world does it attack man. There is much to be said for this opinion. Certain animals, especially of the rodent class, seem to be liable to plague in an epidemic form, but whether it is endemic amongst these animals is not known. That plague is endemic amongst rats is not known. That it occurs in epidemic form is abundantly proved, but whether it is the rat that keeps the bacillus alive from one century to another seems uncertain, and it is unlikely from the very fact that it is so virulent amongst them at times. I would rather regard, from the evidence to hand, plague as being as alien a disease amongst rats as amongst men. If I were to single out any one animal on which one might saddle endemic plague, I would fix upon the marmot (the *Arctomys bobac*) in preference to all others. This marmot inhabits the mountainous backbone of Asia from Mongolia to the Caucasus. It is akin to the squirrel in appearance, and this group of animals seems specially susceptible, for we know that in Western North America the ground squirrel is readily affected in the wild state with the plague bacillus.

It is in the very region the marmot inhabits that we hear of plague from time to time, even when there is no pandemic. Kumaon and Ghurwal come into this geographical category, and at the extreme eastern portion of the

mountain range plague has been known to exist in endemic form since 1878 amongst men when the marmot is known to harbour the disease. This question, however, cannot be settled until more information is obtainable; and the opening up of Asia to the north of the Himalayas by railway will serve to help us to solve the problem. Plague manifests its presence in man more frequently in the form of bubonic plague than in any other form. In Biblical times even the bubo or emerod, as it is spoken of in Leviticus and I. Samuel, was the prominent evidence of the presence of the disease. Surgically a bubo means an enlargement or swelling occurring in a gland anywhere in the body, due to some irritation or inflammation in its neighbourhood. We are familiar with such an occurrence when, should the hand be poisoned, we get a swelling of the glands in the armpit, or, when the skin of the foot is irritated, we get a swelling in the groin. In plague there are three situations in which buboes may be felt. Most frequently it is the groin glands that enlarge, but the glands of the armpit and the neck may be the seat of the swelling. On the other hand, the glands along the front of the spine from the chest to the abdomen may be swollen, but as they are deep-seated, they cannot be made out except by post-mortem examination.

The bubo, however, is not the first indication of the disease; in fact, it is rather a late manifestation, for it may not be until the third day or later that it shows. Like other infections, plague begins with feverishness, headache, backache, a feeling of chilliness, or even a rigor; there is loss of appetite, a foul tongue, usually black in centre, and congested throat; vomi ing is frequent, and diarrhœa or constipation obtains; mental aberration is an early manifestation, and may continue throughout the illness. At times it takes the form of active delirium, or an apathetic type of derangement prevails, the patient being placid and unimpressionless, neither hearing nor seeing properly. The delirium may take the form of apparent suicidal intent, as many get out of bed and make for the window or verandah. There would not appear to be any set purpose in this action, and a fall from the verandah on such occasions is due to accident merely. Around the bubo, or independently, blood is effused beneath the skin, sometimes in large patches of a foot or more square, sometimes in several or many smaller areas in different parts of the body. The appearance of buboes may be early or fairly late in the disease. The bubo or buboes, as there may be several in a group, develop quickly, and in a few hours may reach large dimensions, varying in size from a hazel nut to a Bath bun. There is some local pain over the bubo, and the skin over it becomes red or dusky, and if the patient lives long enough, indications of pus having formed occur about the fifth day, and by the eighth day the skin over the bubo sloughs, a quantity of pus escapes, and a large ragged ulcerating surface is left. As a rule, if the patient lives over the fifth day, recovery may be expected, but the third and fifth days of the illness are the most dangerous. If the eighth day is survived, the hope of recovery is good, the chief danger then being failure of the heart through sudden movement or getting out of bed, walking across the floor, and leaning over the verandah, or staircase railing.

Along with the bubonic form of plague, a septicæmia or acute blood poisoning form of the disease occurs. The signs and symptoms are more acute, the temperature is higher and more sustained, the pulse quicker, buboes do not occur; it may be because the patient dies before there is time for development, and the delirium is more active and uncontrollable. The patient usually dies of acute pulmonary congestion or pneumonia.

The pneumonic form of plague we have heard especially about in the epidemic which is now raging in North China. It is an acute form of the disease, which attacks the lungs so extensively that death comes in two or three days. It is highly infectious, runs rapidly through a household, and occurs with such rapidity and virulence that there is no time even to bury the dead. The plague in North China recalls the accounts given of plague in former epidemics in Europe, and the Black Death, with all its horrors, is abroad in the world. We begin to understand that there may be stages in the development of plague epidemics, reaching from a low to a high degree of virulence, and from a meagre to an extremely dangerous state of infectivity.

Pestis minor.—In attempting to gauge the epidemiology of plague, it may be well to deal with the matter from a historic point of view. In 1893—that is, the year before plague became epidemic in South China—a large number of cases of "buboes," in the groin especially, prevailed throughout the Far East from Singapore to Hong-Kong, and possibly elsewhere. The writer brought up the

matter for discussion at the British Medical Association Branch in Hong-Kong, and several letters were received about the same time from medical men in Singapore and from French doctors in Saigon, asking if in Hong-Kong we had experience of these "buboes," as they had seen so large a number that it might be termed an epidemic.

I termed this outbreak as a "bubo d'emblée," and stated that I had treated thirty-eight cases in thirty-two months.

Going still further back to 1891, I reported to the Medical Society of Hong-Kong twenty-three cases of glandular enlargement met with amongst children in Hong-Kong. There was feverishness, but no throat affection, nor was the parotid gland enlarged as in mumps. The condition puzzled us, and for convenience sake we (the doctors) styled it mumps, although we knew otherwise. This is interesting, for in Astrakhan, in 1877, when plague was in the district, the doctors there also spoke of "a peculiar form of mumps" prevailing there. Again, seeing that glands, except strumous neck glands, are seldom excised, I examined the records of the Government Civil Hospital in Hong-Kong in connection with the excision of glands, and I found the following:—In 1891, 19 groin buboes were excised or scraped; cervical glands, 1. In 1892, I had not the record. In 1893, 27 buboes were excised. In 1894, 12 buboes were excised and scraped. I have searched many hospital reports for records of excision of buboes, and nowhere in the world have I found buboes operated on to the extent which is recorded in Hong-Kong between 1891 and 1894. In the British Navy also, on the China Coast and on the Zanzibar Coast, buboes in sailors were reported and termed climatic bubo. In all these reports, plague, typical plague, was present, or plague subsequently occurred, and I am convinced that the bubo d'emblée, the "peculiar form of mumps," and "climatic buboes" are all cases of *pestis minor*, a disease having a special type, not a mild variety of true plague, but a variety due to a type of bacillus allied to the true plague bacillus, but with less and what may almost be termed a specific variety of the bacillus.

I had a case of climatic bubo in London, in a doctor just home from the Mysore goldfields, where he was on plague duty for a considerable time. Professor Hewlett found in the discharges a bacillus resembling a plague bacillus, but *not conforming with all the tests necessary to stamp the disease* as one due to the presence of the typical plague bacillus. The *non*-conformity is, perhaps, the most interesting point of all from what we now know of plague. It is possible that we are dealing with varieties of plague bacilli which bear distinct relation to the type of the disease which prevails at any given time or place. That "climatic buboes" are neither more nor less than plague due to a special variety of the bacillus (usually termed a pseudo-bacillus) which is met with in pronounced types of the disease, there can be no doubt, and the writer has styled the condition *pestis minor*. It will be seen that by this is not meant a mild clinical variety of virulent bubonic plague, but a disease due to a special strain of the plague bacillus, which runs a definite course and only gives rise to its like (for a time) in other people. That *pestis minor* runs also concurrently with true plague was well illustrated during the outbreak on the Volga in 1877. At Astrakhan true plague prevailed, and many deaths occurred, but in a town 150 miles higher up the Volga the people suffered from an outbreak of buboes which amounted to an epidemic, but no deaths resulted; they, in fact, had the specific type of mild infection—*pestis minor*.

I would classify the possible stages of plague infection of a country as those of:—

(1) *Pestis minor*.

(2) Bubonic plague.

(3) Pneumonic plague.

That these are related the one to the other would seem incontestable; that each possesses a special variety or type of virulence due to peculiar characters of its bacillus, and transmitted in different ways in each type, would also seem true. The rat-flea infection plays, no doubt, a part in this scheme, but, as Dr. Hossack, of Calcutta, remarks, it is but a link in a chain of some length—a chain, we would add, in which other animals and man play a part.

I have devoted considerable space to this part of the question, because it may be of importance in estimating the approach of plague in any country, and it would be well to keep this point in view in our hospitals in this country, and to watch if cases of non-venereal buboes are becoming more prevalent. In this way we might hope to gauge the proximity of true plague in its virulent forms.

It may be interesting and instructive to refer to the history of the plague in Mongolia, in connection with the Manchurian outbreak, with which it is no doubt directly connected.

In the district of Aksha, in the Transbaikal

Province of Siberia, plague has been known to exist since 1888. Aksha is in longitude 115° east, and latitude 50° north, and the principal centre of plague is round Tzagan-olui, a place close on the Russo-Mongolian frontier. The disease is known in that district as *tchuma*, the Russian term for plague. Here the tarbagan (*A. bobac*) is regarded as the cause of the disease in man. The tarbagan is much sought after by the Cossacks and Buriats who inhabit the district, for the sake of the fat which accumulates chiefly in the abdomen towards the autumn, and just before the animal retires into its hibernating quarters in September.

The tarbagan is in some years attacked by an epizoötic with the following symptoms: the animal becomes languid and ceases to bark; its gait is unsteady, and under one shoulder there sometimes appears a reddish, tense swelling; if far from its hole, the animal fails to find it, and if it reaches its hole, the other healthy animals refuse it admittance, when it falls a prey to wolves, who have a great liking for marmot, whether healthy or diseased. The wolves do not contract the disease from eating the marmot, and this scavenging by the wolves is considered the chief reason why men escape from the disease so frequently as they do. Should, however, people handle a marmot dead of the disease, sickness is almost sure to follow, and death, as a rule, occurs in a few days. This disease, which is endemic in the district referred to, is now recognised locally as identical with plague, but its spread is confined to the family of the person first attacked. It would seem probable that the fleas of this animal communicate the disease to the members of the household, and that only those bitten by them are attacked by the disease.

A different state of affairs, however, exists in a district in Eastern Mongolia, some 480 miles further south. In this district plague was known to exist in 1888, and every year since it has recurred regularly, now mild, now more severe. Although tarbagan are numerous in the district, no observers nor the people themselves attribute the disease to infection from marmots, rats, or domestic animals, as none of these have been found diseased. These observations are interesting, and the behaviour of the disease in the two localities is equally so. In the Siberian centre the disease is occasional, coming only when the marmot is affected, and seldom spreading beyond the house where a diseased marmot has been handled. In Mongolia the animals are not known to be infected, the disease occurs annually in the summer, and it spreads in an epidemic form amongst the people over a considerable area. Here we have two forms of spread, one occasional and attacking members of one household, the other regularly recurring, and affecting the neighbourhood in an epidemic form. The former is from infected animals, the latter from infected people. In the Mongolian outbreaks pneumonic forms occur in about one-third of the persons attacked. It is interesting to note that in the Mongolian centre a number of Manchurians have settled, and between the two places, no doubt, people pass backwards and forwards from time to time, and since the railway opened intercommunication has become more free. The disease which appeared in Manchuria in 1910 is more of the nature of that which prevails in the Mongolian centre, but the pneumonic form prevails. Here we would seem to have interesting material for consideration. One centre is Siberia, where the disease reaches man from an animal, the marmot, and appears in endemic form; a second centre is Mongolia, where the disease is partly bubonic and partly pneumonic; a third centre is Manchuria, where the pneumonic type prevails. This would serve to support the belief that the plague bacillus passes through stages of development in type: first, the variety that is brought about by the bite of fleas of an animal suffering from the disease, but not going further; second, the type which becomes epidemic by passing from man to man, probably by fleas carrying infection from one individual to another; third, the type that passes from man to man without the intervention of a carrier or by insects as well.

The lesson to be learned from this is that there are three stages in this disease. *Pestis minor*, carried only by insects from diseased animals, is always local—a household outbreak, in fact—in which a pseudo-plague bacillus is found in man. Bubonic plague is carried from man to man by insects. Pneumonic plague passes from man to man without the intervention of insects. The virulence of each variety gathers in intensity. Time is required for one type to change to another more virulent, each variety propagates its like until, by prolonged cultivation in the blood and tissues of a particular animal, or in man, it changes its type and becomes specific for that animal. As the tuberculosis of animals may in time and in suitable soil change in type, so that it develops in man, and then is directly transmitted from man to man, so is plague in time altered in

type, so that it no longer requires an animal host, but in times of epidemic passes from man to man, and becomes wholly a disease of human beings.

The stages would appear thus to be:—

(1) Disease in animals.

(2) *Pestis minor*, conveyed by infected insects.

(3) Bubonic plague, sporadic cases, carried from animals to man by insects.

(4) Epidemic bubonic plague, carried from man to man by insects.

(5) Pneumonic plague, passing from man to man directly, or conveyed by insects.

It would seem, therefore, that severe as bubonic plague has been in China and India, yet a worse form may develop, for pneumonic plague is the culmination of this chain of virulence, and China and India may have been but the fostering beds in the development of the bacillus which has now attained its highest development in Manchuria, and may pass over the world, as it has frequently done before, in the form of the Black Death. At present, science offers no means of preventing such a calamity, except it be a preventitive such as Haffkine's prophylactic serum, which would seem to have done good service in India, where bubonic plague has chiefly prevailed.

That some such scheme of development appears probable, all evidence indicates. We had first in the Indo-China and Chinese coast climatic buboes, or *pestis minor*, then bubonic plague in South China, which, transmitted to India, continued its type there; then during the continuance of bubonic plague in China and India, the appearance of at first a few and then a number of cases of pneumonic type; and finally the appearance and continuance of a primary pneumonic plague in North China.

Infection by rat fleas is sufficient to explain sporadic cases of bubonic plague, and plague endemicity, but it is wholly inadequate to explain an epidemic of bubonic plague which can only occur by infection from man to man, possibly by insect carriers.

An important point to be observed in the epidemiology of plague is that animals, chiefly rodents, the rat in many places, the marmot in North China, the squirrel in the United States, &c., may suffer from plague for years without infecting mankind, except in a sporadic way. Then suddenly an outbreak occurs which prevails in an epidemic form. In Northern China this has been proved to be the case, and in any country where rodents are infected, the same sequence may be anticipated. Rats have been found to be infected in Britain, in Glasgow, in the Port of London, and in Suffolk; also in Germany, in Hamburg, and elsewhere; squirrels are known to be infected in the United States, more especially on the Pacific slope. In these countries small outbreaks of a sporadic nature have occurred from time to time. The outlook, reasoning from experience, is not hopeful, for the peoples of these countries are dwelling in places in which rodents are infected, and at any moment the disease may appear in an epidemic form in man.

DISCUSSION.

Professor W. J. R. SIMPSON, in opening the discussion, said the maps and facts the author had placed before his audience showed that the plague had spread in a very short time over a considerable part of the world. About fifteen years ago the disease was considered to be extinct, except in certain very remote parts of which mention had been made, the reason of its abolition being put down to civilisation and the progress of the nineteenth century. It had recently reappeared, however, with renewed strength, and it had come to stay. He agreed with the author that plague was a formidable disease, not only to Asiatics but also to Europeans. Thirteen years ago Mr. Birdwood, after his return from Poona, read a very interesting paper before the Society on "The Plague in Bombay." Having recently arrived from India, where he had been at work in Bombay and Poona, he (Professor Simpson) ventured at that meeting to differ from the views taken in regard to plague by some of the speakers. He viewed the disease as an expanding one, and emphasised the fact that although the operations for its extermination seemed to be successful, the organisation at that time was entirely inadequate and unscientific, and that it was impossible by such means to prevent the spread of plague. Some 30,000 deaths had at that time occurred from plague in India, but since that time over 7,000,000 deaths had taken place. Only last week, and for many weeks previous to it, there had been 20,000 deaths from plague in India. The same was the case in China. The differentiation the author had made between the two forms of disease arising from the tarbagan and also the pneumonic form in China was very interesting. Whether the tarbagan produced the pneumonic form he was not prepared to say, because pneumonic plague could be obtained without the tarbagan. It occurred in West Africa, where bubonic plague gradually developed into a virulent pneumonic type. In the West African epidemic the whole of the cases after a short time were pneumonic, and nearly every patient died. Plague was an expanding disease, and once it got into a country it was difficult to get it out. Not a single word would have been heard about the plague in Northern China if it had not occurred on the route of the

Trans-Siberian Railway. Telegrams were published in the daily papers saying that the plague had subsided. It had undoubtedly subsided in those particular localities, and nothing more would be heard about it until that form of plague was seen a good deal further west. China was a large country, and whatever happened there was not known to the European unless it occurred on the railway or at some missionary station. The danger of pneumonic plague was its infectious nature; it was carried from person to person like influenza. Many cases were not recognised, and they constituted the great danger. So far as immunity was concerned, he believed Europeans were no better off than they had been hitherto. He did not believe Europeans were immune from the disease once it got among them, and it was only by intelligent organisation that they would be able to fight it. He believed that it was absolutely essential, as the author had stated, that even in England there should be a proper organisation against the rat plague, the dangers of which the author had so interestingly brought to their notice.

Dr. L. W. SAMBON said the author was the first to state that the disease which appeared in Hong-Kong was the plague, but nobody believed him at the time. While doing some operative work, Dr. Cantlie wounded himself, and as the wound became poisoned, he left Hong-Kong and travelled for a time. On landing in Japan he heard that plague had broken out in China, and, together with his wife, Dr. Cantlie at once went back to Hong-Kong. On arriving at Hong-Kong he met a Japanese doctor, Dr. Kitasato, who had begun to investigate the disease, and who thought he had discovered its cause. At the same time a French naval doctor had just landed—Dr. Yersin—who was altogether unprovided with the necessary apparatus for scientific investigation. Dr. Cantlie at once put his laboratory at Yersin's disposal, and Mrs. Cantlie prepared culture media; and by means of the help thus rendered Yersin discovered the organism which caused plague. The epidemic of plague which overran the world in the fourteenth century began exactly in the same way as the present epidemic. It came down from the plateau where the marmot lived towards China; it then spread to India and various parts of Asia, and finally appeared in the Crimea, taking exactly the same route that the disease was taking at the present day. But at the present day means of communication both by land and sea had multiplied so much that the danger was far greater. The present pandemic of plague was the widest that had ever been known in history, because for the first time Australia, South Africa, and America had been attacked. The one point in favour of the present situation was that precise knowledge was available of the cause and the mode of the spread of plague. The ancients knew that the rat was the great carrier of the disease, and they also knew that vermin of smaller kinds, blood-sucking insects and flies, were capable of conveying the plague. All the measures taken by the ancients were directed against the rat, and the insects that carried it from rat to man and from man to man. In Aesculapius, the God of Medicine, with his staff with a snake entwined, there was an interesting record of one of the most glorious victories of man over a fearful scourge, namely plague. That snake was symbolical of the introduction into Europe, and the use in many parts of the East, of the snake to destroy the rats that carried the plague. The pine-cone, another symbol that was usually placed by the side of the Greek God of Medicine, referred to the incense yielded by the pine-cone. This served to disinfect the houses and to destroy the insects which became dangerous in time of plague. Unfortunately the knowledge of the ancients with regard to the etiology of plague was forgotten during the Middle Ages. Dogs, cats, rabbits, pigeons, and all animals which might, by breeding large numbers of fleas, endanger life during an epidemic, were destroyed in the Middle Ages, because they were the means of conveying insects that might carry the disease from the sick to the healthy. At the same time that Yersin and Kitasato made their discoveries, another French savant, Dr. Simond, pointed out that the flea was probably the means by which the parasite passed from rat to rat, and from rat to man; and now, through the work of numerous investigators both British and foreign, and more especially through the work of the last commission which had been studying plague in India, the fact had been thoroughly established that the rat was the great carrier of plague, especially across the seas, and that fleas amongst insects were the most important inoculators of the disease. Other insects, however, had to be considered. The feature which made the epidemiology of plague so complex, and the fight against it so difficult, was the wide zoological distribution of the disease. The marmot appeared to be the normal host of the disease, but it might spread to other rodents. The peculiar ground squirrel of California had become infected, and would keep up the epidemic there for years, and it was known in California that an outbreak of plague might occur there at any time. The people were therefore prepared for such a contingency. In India the bandicoot rat became a factor in the epidemiology of the disease, while in Australia rabbits might eventually spread and maintain the epidemic. In Suffolk, hares, rabbits, and other animals had been found infected with plague. Very probably the bacillus in passing from one species of animal to another became adapted to that species, and therefore the disease might be prevalent for many years among such animals, and only a few sporadic cases occur amongst men; but when favourable conditions arose men might become the host for a time. Bed-bugs and lice might also convey the infection, and people that were covered with such vermin might become very dangerous carriers of the disease. Plague had been called the disease of the poor, because they were frequently

covered with vermin, which were the carriers not only of plague but of many other diseases. Very little was known about the most common diseases in this country, such as measles, scarlet fever, diphtheria, whooping-cough and mumps, which were decimating the children, whereas so far as tropical diseases were concerned wonderful progress had been made. A commission which was sent to Africa discovered the cause of the mysterious sleeping-sickness in three months. Was it not time that a thorough investigation was made of such maladies? Most of the diseases had not hitherto been thoroughly understood, because it had not been realised that they were common not only to man, but to a number of the lower animals. Hitherto medical men and veterinary surgeons had worked on different lines; but it was essential, if knowledge was to be obtained about the diseases of man, to ascertain in what way they were connected with similar diseases of animals.

Dr. F. M. SANDWITH said the author did not by any means stand alone in thinking that the plague which already existed in this country was a very serious matter. He thought it was fair to assume that as the plague began in a similar way in many other countries, it would behave in much the same way in this country. He happened to be stationed in Egypt, which had been a great cradle of plague, when the news of the outbreak of the disease in Hong-Kong was first published, and a commission was sent to India for the purpose of ascertaining how the scourge should be treated. At that time, 1888-1889, the work in India was neither scientific nor successful, and the commission brought back word that however the plague was managed in Egypt, the Indian method should not be imitated. It was soon discovered that rats were the chief cause of the spread of the disease; and in that connection he wished to point out that the author was the first person in London, and he believed the first in Europe, to draw the attention of the medical profession to the fact that rats were a very important factor in the spread of plague. As had been stated years ago, plague was not a human disease occasionally communicated to rats; it was, rather, a marmot or rat disease to which man sometimes fell a victim. When all sorts of quarantine methods against men were established, he always regretted he had not the power of a caricaturist to paint a rat or a rat-flea lurking round the corner laughing at human beings making such fools of themselves! We should never be able to prevent plague by destroying only those rats and rat-fleas on board ships in which the captains reported that plague existed; all rats and rat-fleas must be killed on all ships coming from infected ports. The author had reminded them that a better organisation now existed than in times past. There was another comfort in the fact that while man was better equipped than in the days of 1666, the type of rat had also changed, and was less likely to cause plague, because he was a shy creature who did not run about all over the houses, as he still did in India and some other parts of the world. The present knowledge possessed of the disease was all-important. By means of a bacillus, a rat, a flea, and a fool of a man, plague could be produced at any time, provided the temperature was suitable; and if the disease could be produced it also meant that it could be prevented. It would be a crying shame if England, the great pioneer in sanitary matters in the world, ever allowed plague to become rampant in this country, because medical men knew how to prevent it, and it was their own fault if the people did not allow them to do so. It was necessary to have a temperature of between 50° F. and 85° F. to spread plague. That temperature was not obtained in this country in March, but it did occur in England in that modified wintry time which was called summer.

Surgeon-General G. J. H. EVATT said that he was stationed in China as Principal Medical Officer of the troops immediately after the time the author was there, and from the experience he then obtained he was certain there could not be in the whole world a place where every sanitary precaution was more outraged than in Hong-Kong. The overcrowding of the people and the want of sanitary appliances were simply too dreadful for words. From Hong-Kong the plague was passed by means of the opium ships and transports to Bombay, and many millions of our Indian subjects had died as a result. The practical lesson to be learned was the necessity of the general education of the people in the knowledge of the laws of health, and the establishment of a well-paid and well-instructed sanitary service which would be able to do its duty well without the interference of the local authorities. As the manager of a group of schools in the East-End, he paid a visit to one of the schools during the past week, and there saw twenty-four children who were sitting by themselves out of a class of fifty because the teacher said they were lousy. The verminous condition of some of the children in the slums was appalling. With a number of other London physicians, he had endeavoured to get the teaching of hygiene made part of the educational course, and with that object in view deputations had waited upon two Ministers of Education, both of whom, he was sorry to say, were not sympathetic.

The CHAIRMAN, in proposing a cordial vote of thanks to the author for his most interesting paper, said he desired to refer to one point that had been mentioned in order to remove any possible misapprehension. Dr. Cantlie had spoken of the plague in London; what he really meant was plague in the Port of London brought in by the shipping; it had not got ashore. In every large community cases occurred from time to time that raised a suspicion of plague. Every suspicious case that had occurred in London for a very considerable number of years had been

inspected by the author personally, and had also been subjected to bacteriological examination by Dr. Klein; and they had always been able to satisfy themselves that plague was not present. He hoped that condition would continue. Surgeon-General Evatt had referred to the need for removing verminous conditions from London. For a great number of years the sanitary authorities had possessed an Act which enabled them to provide stations for that purpose, but it had been grievously neglected in London. It was a want that the sanitary authorities could provide in London, but there was no power, such as the London County Council, to compel them to move in the matter. Some of the districts had made provision, but in others it was lamentably wanting.

The resolution of thanks was then put and carried unanimously.

Dr. Cantlie, in reply, after thanking the various speakers for the kind remarks they had made and the audience for according him such a hearty vote of thanks, said that the Chairman kept a very keen eye on plague in London. When the scare with regard to that disease first occurred, Sir Shirley Murphy closely investigated several cases that were reported by the doctors. He remembered one Christmas Eve the Chairman and himself inspecting the Chinamen in the opium dens in the East-End of London, searching for a case of plague. It was eventually discovered that a man had died, but whether he had plague or not it was impossible to discover. Everybody in London could sleep soundly in their beds so far as plague was concerned, because they might rest assured that everything it was possible to do was being done by the medical officers of the Port of London. A number of rats had been recently examined in the Port of London, and rats with plague had been found on board several ships and also at the docks. A large number of rats had been destroyed in the Port of London, so that the right thing was being done, because the only way to get rid of the trouble was to destroy the rats. In Sydney sixpence was paid for each rat destroyed, and this proved so effective that it was believed there was not a single rat left in the town. He contended it would also pay the authorities in this country to pay sixpence a tail for each rat destroyed, as, apart from a health point of view, and the getting rid of any fear of plague, £15,000,000 worth of grain would be saved every year, so that the United Kingdom wonld not be so dependent upon America and other countries for its food supplies. The Australians found that it paid, where sheep scab or other infectious disease broke out, to set fire to the country and destroy, if necessary, everything along the track taken by the sheep. Yersin, to whom Dr. Sambon had referred, independently rediscovered the plague bacillus previously discovered by the Japanese. He died as a result of his devotion to science, which was the poorer by his loss.

THE SUEZ CANAL AND ITS TRAFFIC.

Some interesting data regarding the Suez Canal traffic are supplied in the Foreign Office Consular Report on the trade of Port Said and Suez for 1909. From this it appears that the Canal receipts in that year were the highest reached since the opening, and amounted to 120,612,677 francs (£4,825,707) as compared with 108,452,235 francs (£4,338,089) in 1908. The total number of vessels that passed through the Canal in 1909 was 4,239, with a net tonnage of 15,407,527, as compared with 3,795 vessels, of 13,633,283 tonnage, in 1908. Of the former, 2,911 were merchant ships, 972 mail steamers, and 104 men-of-war and transports. The mean net tonnage has risen from 1,000 tons in 1871 to 2,000 tons in 1890, and to 3,635 tons in 1909. The average time of transit for a mail steamer is now fifteen hours, and for a cargo boat eighteen hours. The percentage in number of British ships in 1909 was 60, German percentage being 14, and the Netherlands coming third with 5·9. The transit dues have of course, varied considerably. Originally, in 1869, the tariff was 10 francs per ton, and from 1874 to 1877 it was raised to 13 francs. Since then the tariff has been gradually reduced to 7 francs 25 cents on January 1st last. The 10 francs rate per head for passengers has never been changed.

It may be interesting to recall here that the first concession for the Canal was given to M. Ferdinand de Lesseps by Said Pasha of Egypt in 1854, this being ratified by a second concession in 1856. The company was constituted at Paris in December 1858, with a capital of 400,000 shares of £20 each, of which 176,602 shares were subscribed for by Said Pasha and his successor, the Khedive Ismail. The Khedive's shares were purchased by the British Government in 1875 for £4,076,622. They are now worth about £34,000,000, and bring in an annual revenue of over one million sterling per annum. After numerous soundings in the Gulf of Pelusium, the spot on which the town of Port Said now stands was eventually chosen as the northern entrance, and the first sod was turned by M. de Lesseps on the sea front of Quai Eugénie, April 25th, 1859. The Canal was opened to traffic on November 17th, 1869. The entire length of the Canal is about 100 miles. The navigable dimensions in 1909 were practically double what they were in 1869. The original depth was eight metres, and the original bottom width twenty-two metres; but now the minimum depth is nine and a half metres, and the bottom width forty-five metres. The work of widening and deepening the Canal is being steadily pursued, with the intention of attaining a minimum width of forty-five metres and a depth of eleven metres. At present ships drawing up to twenty-eight feet (eight and a half metres) are allowed to pass through the Canal, but it is anticipated that within four years' time the maximum draught allowed will be increased to thirty feet.

The proposed extension of the Suez Canal Company's lease comprises a variety of financial provisions of considerable importance; but inasmuch as the current lease does not expire till 1968, it is obvious that much may happen before that date, whether in the shape of trans-continental railways or other improvements of communications to modify existing conditions, and thus make consideration of the details of the new lease somewhat premature at the present moment.

ACCIDENTS IN FACTORIES.

In 1908 a Departmental Committee was appointed "to inquire into the causes and circumstances of the increase in the number of reported accidents in certain classes of factories and workshops and other premises under the Factory Acts, and to report what additional precautionary measures are, in their opinion, necessary or desirable." The Committee, under the chairmanship of Mr. H. J. Tennant, M.P., took evidence from fifty-eight witnesses, and spent nine days in visiting factories. Their report has just been issued as a Parliamentary Paper [Cd. 5535].

The Committee are of opinion that the accident risk for the ten years from 1897 to 1907 probably remained almost constant. Since 1907 there has been a tendency for this risk to decrease—a result, no doubt, that is due partly to the Workmen's Compensation Act, partly to the greater experience of employers in the efficient guarding of machinery, and partly to the efforts of the factory inspectors. It is also probable that any increase took place chiefly in the class of unpreventable accidents, while improvement has been effected as regards preventable accidents.

Nevertheless, the Committee think the accident risk is higher than it should be, and they make many suggestions for improving the factory law and the methods of its administration. They dwell upon the importance of co-operation between factory inspectors, employers and workpeople, and recommend periodic conferences between representatives of the three classes for the discussion of industrial dangers and methods of prevention in particular trades or districts. The Committee do not propose that such conferences should supersede the present method of enforcing the law, but they contemplate that they will often have the effect of avoiding the necessity for legal proceedings, and also of enabling the inspector to secure the carrying out more quickly of precautions of a novel kind such as he hesitates to try to enforce by resorting to legal proceedings.

The Committee make various recommendations directed towards strengthening the existing regulations as to the fencing of machinery, the provision of safety appliances, and the cleaning of machinery in motion. They also devote attention to the question of the lifting and carrying of heavy weights, and suggest the desirability of fixing by law the maximum weights which young persons should be allowed to carry. The present system of appointment of factory inspectors is also discussed, but upon this point the opinions of the Committee are somewhat divided.

THE MINING INDUSTRY IN INDIA IN 1909.

The report of the Chief Inspector of Mines in India for the calendar year 1909 shows that, for the first time since the Indian Mines Act came into force, a decrease in the number of workers has to be recorded, and, compared with the preceding year, this decrease amounts to 23,591 operatives, or over 14 per cent. This decrease is not accounted for by a slackness in trade in any one particular mineral, but is due apparently to a wave of industrial depression which swept over the country last year, and has not yet entirely receded.

Coal received a decided set-back in its out-turn, the demand being by no means equal to the supply; and, until collieries were able to accommodate their working to the situation, stocks steadily accumulated, and at the time of the writing of the present report were only just beginning to diminish. The Chief Inspector considers on the whole that the coal industry is in a healthier condition than it was two years ago. Owing to the labour troubles in Australia, Indian coal had an opportunity of entering new markets, and if the shipments contained only clean and carefully-selected coal, the product would undoubtedly strengthen its hold on those markets. The output for 1909 was 11,294,227 tons, as compared with 12,149,020 tons in 1908, showing a decrease of 8 per cent., the diminution being principally in the Jharia district. The Central Provinces area, on the other hand, has increased its output by 10 per cent., and Assam and Baluchistan have also made progress to the extent of 11 per cent. and 16 per cent. respectively. The output of mica has decreased by 709 tons, or 30 per cent., the falling-off applying to all the producing districts in about equal proportions. The Hazanbagh mica tract must be one of the richest mica deposits in the world, but unfortunately mining has been here conducted with utter disregard for the future. Where fairly productive veins are outcropping at the surface, they are worked down as long as the yield is good, the water question not baffling or burdensome, and the labour ample to raise the material cheaply by hand. Should any alteration appear in any one of those conditions, the mine is abandoned, either becoming waterlogged or covered with *débris*, the site of the vein itself often being obliterated, so that no encouragement is offered to any future worker. In the opinion of the Chief Inspector the only way to safeguard the mineral is to impose restrictions as to working upon leaseholders.

The manganese industry has continued the retrograde movement which set in at the end of 1907, there being a great falling away from the high-water mark of that year, when the output

was 642,082 tons, as compared with 494,942 tons in 1908 and 357,205 in 1909. Indian manganese is a very high-grade ore, which is not costly to mine, and must always command a market, excepting during the times of unusual depression. The output of gems from Burma has materially increased during 1909, these being entirely derived from the Mogok branch of the Burma Ruby Mines. Tin, all of which is mined in Burma, has also very considerably increased, though the total output is still only 1,520 cwts. The output of gold has again decreased, the figures for 1909 being 5,615 ozs., as against 7,212 for 1908, all being from the Dharwar goldfield. The outlook, however, is not even as promising as the figures would seem to indicate, as notices have been received to the effect that some of the principal mines were closed down at the end of the year.

The number of fatal accidents in mines that occurred during 1909 was 126, involving the loss of 152 lives, being a decrease of 42 as compared with those of the previous year. In coal-mines, however, the death-rate (10·53 per million tons raised), though diminishing, is still much too high, and, as the Chief Inspector remarks, shows very clearly that the Indian miner has a great deal to learn in the way of taking care of himself, and must be taught how to do it.

HOME INDUSTRIES.

The Coal Industry.—The exports of coal, coke, and patent fuel amounted to 5,222,941 tons in January last, as compared with 4,407,480 tons in January 1910, and with 4,494,504 tons in January 1909, which is satisfactory; but the home industrial demand is not active, and the unusually mild winter has, of course, affected the home household demand. But the aggregate demand is less than might have been expected, having regard to the reviving demand for the world's industrial products. It must, however, be remembered that there were large reserves of coal in stock from the depression of previous years, particularly in January. The prolonged lock-out in the shipbuilding trade seriously reduced the industrial consumption of coal. The shipyards themselves do not require much coal, but the closing of the shipyards meant the closing of some of the steelworks, and the closing or slowing down of some of the ironworks. And, so far as the demand for Welsh coal is concerned—and apart from labour troubles—oil fuel, electric propulsion, and internal-combustion engines may well affect the dominance of Welsh smokeless coal in the marine market. On the whole, however, it may be expected that both in the home and export markets there will be improvement as the year advances.

Short Time in the Cotton Industry.—At the monthly meeting of the general committee of the Master Spinners' Federation held last week, the question of running short time on an organised scale was discussed, and previous to the meeting it was suggested that there might be an effort made to stop the mills engaged on American cotton on Saturday mornings for a couple of months. There is to be a mass meeting to-day at which it will be proposed that the section using American cotton shall ballot on the question of Saturday closing during three months. It is believed that the meeting will approve of the ballot, but it is doubtful whether the necessary majority will be obtained. In the past, 80 per cent. of the members have been sufficient to carry the point, but now it is to be 90 per cent. Anyway it would be some weeks before the proposed curtailment could begin, for at the present time the Lancashire mills are at full swing, and much may happen in a month. The outlook cannot be said to be unfavourable. Raw material prices show decline, it is not likely there will be any scarcity in American qualities, and there will be a plentiful supply of Egyptian cotton. Throughout the world consumption is improving, and there are expectations of a larger turnover in the near future. Shipments continue heavy, and the home trade is showing signs of improvement. But though the general outlook is not unsatisfactory, production continues too large for the requirements of users.

The New Salt Process.—A good deal is being heard just now about a new patent process for the manufacture of salt invented by Mr. James Hodgkinson, of Manchester. It is claimed for this process that it will be able to produce salt at one-fifth of the present cost, owing to the utilisation of the waste steam and hot gases from one pan to precipitate the brine in other pans, the varying degree of heat producing varying sizes of crystals. The vacuum-process salt can be manufactured at 4*s.* per ton or even less, so that if the new process can save four-fifths of the cost of manufacture it means the production of salt at a cost of about 10*d.* per ton. It may be doubted whether that is possible. The Salt Union has just completed large new works at Weston Point, and it is not easy to understand why they should have adopted the vacuum process, as they have done, when they could have availed themselves of the Hodgkinson process, if the explanation is not be found in their belief, presumably reached after due inquiry, that the cost of production cannot be reduced as claimed.

Bank of England Stock.—The present quotation of Bank of England stock is about 260, which, allowing for the half-year's dividend accrued, gives a return to the purchaser of £3 10*s.* 6*d.* This stock at its present price—it is, of course, a Trustee security—is inviting. Eleven years ago it touched 367, which meant a yield to the investor of only £2 14*s.* 6*d.* per cent. Ten per cent. was paid on the stock from October 1896 to October 1903, but since then it has been only 9 per cent. per annum, and the forthcoming distribution will be at the same rate, although it is believed that the

profits of the half-year would have warranted a return to the 10 per cent. distribution. It is curious that the profits for years past have apparently remained stationary. The last return of the half-year has regularly shown that the amount of the "rest," or undivided profit, is sufficient to pay 4½ per cent. for the six months and no more. It is improbable that the profits of the Bank of England do not alter considerably from one year to another, and it may be taken that the directors prefer to utilise surplus profits in writing off investments, or in some other way, at times when the amount would justify a return to 10 per cent. It is believed that the Bank's secret reserves have been largely increased by the policy of retaining the dividend at 9 per cent. per annum.

The Exodus from the Rural Districts.—The tide of emigration from Cumberland, Westmorland, and North Lancashire continues, and is becoming a matter of grave moment to the districts concerned. The emigrants are the flower of the agricultural population and rural artisans, and in many cases they go out not only with a living in their fingers but with money in their pockets. Large parties of young farmers, farm servants old and young, and tradesmen from the villages and small towns, have been leaving in batches of twenty and thirty in a party. Some of the large steamers bound for Canada and the States have taken large numbers of them. Here is one suggestive report of the Candlemas hirings:—"Servants seeking engagements seemed scarcely so numerous as usual, and were mostly composed of youths, with a sprinkling of young women and girls. This was no doubt due to the fact that a large number of agricultural servants have recently emigrated from Cumberland and the Border districts to Canada. Others are due to depart in March, and, what seems to be more serious still for local agriculture, it is apparently the best men who are going."

NOTES ON BOOKS.

THE BACILLUS OF LONG LIFE. By Loudon M. Douglas, F.R.S.E. London and Edinburgh: T. C. & E. C. Jack. 5*s*. net.

A popular account of a popular nostrum. A year or so ago, Professor Metchnikoff's remarkable book on the "Prolongation of Human Life" set everybody drinking sour milk. Some people benefited by it, others suffered, and on a great many it probably had no particular effect whatever. Metchnikoff, after long and laborious investigations, came to the conclusion that senility was caused by the action of putrefactive organisms in the digestive tract, especially in the larger intestine, and that this action could be controlled and prevented by the *bacillus Bulgaricus*, the special organism present in the various preparations of fermented or soured milk used by different races of mankind. Hence a large demand for these preparations, and a considerable consumption of them. Mr. Douglas gives a history of the subject, a description of the original empirical methods by which soured milk was made, and an account of the processes by which the purer and more scientific products of the present day are manufactured.

THE GYROSCOPE. By V. E. Johnson, M.A. London: E. & F. N. Spon. 1*s*. 6*d*. net.

This little volume is founded on a series of articles contributed to the *Model Engineer* in 1909, and it constitutes, as the sub-title indicates, "an experimental study from spinning-top to mono-rail." Beginning with the simplest experiments with a gyroscopic top, Mr. Johnson advances through a number of trials of graduated complexity, to a full and practical explanation of the mono-rail. He also adds directions for the construction of the models with which the experiments should be made. The book is written in very simple language, and should be much appreciated by any lad of a mechanical turn of mind.

GENERAL NOTES.

ENTOMOLOGICAL RESEARCH.—A course of lectures on this subject is being delivered at the Imperial College of Science and Technology by Mr. Maxwell-Lefroy, Imperial Entomologist to the Government of India. As illustrating the importance of the question, Mr. Maxwell-Lefroy, in his first lecture, mentioned that the losses through insect pests to agriculture in the United States were estimated at £60,000,000 a year. He pointed out, too, that practical entomology was not concerned merely with pests. It had to do with such profitable industries as silk manufacture, bee-keeping, and the lac industry, in all of which there was a large scope for improvement. It was, however, recent discoveries as to the spread of disease by insects that had most largely directed attention to the work of the economic entomologist. In the cases of malaria, yellow fever, flariasis (which caused fever, ague, and elephantiasis), plague, cholera, and sleeping-sickness, the transmitting insect was at least as important a factor as the actual organism which caused the disease, and was far easier to deal with. If we were to colonise the tropics, if we were to people them with healthy races, to develop them agriculturally, and to render available the immense amount of raw material they were capable of producing for England's manufactures and trade, it would only be when we had organised entomology and successfully tackled the insect transmitters of disease.

A NEW HEMP-STRIPPING MACHINE.—A hemp-stripping machine, invented by a resident of Manila, and manufactured in Hong-Kong, is being tested in

the Philippines. The machine is an adaptation of the Philippine hand method of hemp-stripping. It consists of several rollers and cutters mounted in a framework 12 feet long, 4 feet high, and 4 feet wide, the machine being mounted on skids, so that it can be drawn about the hemp-fields by an ox or cariboo. The machine strips the hemp from butt to tip, the butt-stripper preparing the stalk for passing through the machine by removing all secondary fibre, with the result that only the first-class fibre is saved. It is claimed by the owners that with twelve men the machine will do the work of forty hand-strippers. Inasmuch as this is the first serious effort to use machines in hemp production, the results are of great interest to all engaged in the industry.

Infusorial Earth in Bohemia.—Kieselguhr, or infusorial earth, occurs in the bogs where the mud is obtained for the famous "moorbäder" (mud-baths) of the Bohemian health resorts. In the vicinity of Soos, a village at the foot of the Erzgebirge, the Kieselguhr is found in small quantities in the mud of the bogs owned by the city of Carlsbad. At Franzensbad the infusorial earth underlies the extensive bogs owned by the city. It is obtainable in almost unlimited quantity. The substance is white, yellowish, or grey in colour, and exists in chalk-like form. It is moulded, burned or otherwise treated for the manufacture of pottery and statuary, gold edges, *papier-maché*, dynamite, putty, adulterants for soap, caoutchouc, and carbolic acid preparations. A non-conductor of heat and electricity, it is employed as a filling in the walls of ice-chests and ice-houses, and for insulation purposes.

The World's Gold Production.—The production of the precious metals, the enormous development of which is one of the characteristics of the last twenty-five years, continued to increase last year, less rapidly however, as regards gold, than in the previous year. The total value of the world's gold production in 1910 amounted to 97 millions sterling as compared with 95 millions in 1909, 92 millions in 1908, and 85 millions in 1907. During the last twenty years, exception being made of the period of the South African War, the year 1896 is the only one in which the rate of progress was lower than in 1910. At the present time the production of gold is four and a half times greater than it was a quarter of a century ago. Then the Transvaal, which now yields gold to the value of 32 millions sterling, produced nothing, while Rhodesia, which twenty-five years ago did not count as a gold-producing country, now yields the precious metal to the value of nearly 3 millions. Western Australia, in the same way, which then produced nothing, now figures for 10 millions. The production of the United States has increased from 7 millions in 1890 to nearly 20 millions at the present time. Last year Russia's gold production amounted to over 9 millions, that of Mexico to 5 millions, British India to over 2 millions, and Canada to over 2 millions.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoon, at 4.30 o'clock:—

March 15.—Colonel Charles Edward Cassal, V.D., F.I.C., "The Adulteration of Food." The Right Hon. the Lord Mayor of London will preside.

Wednesday evenings, at 8 o'clock:—

March 22.—Arthur Charles Davis, F.C.S., Assoc.Inst.C.E., "The Manufacture of Portland Cement."

March 29.—George B. Heming, "Art Education in Jewellery and Goldsmithing and Allied Trades." Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., will preside.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

March 16.—Claude Hamilton Archer Hill, I.C.S., C.S.I., C.I.E., "Education in India." The Right Hon. Lord Northcote, G.C.M.G., G.C.I.E., C.B., will preside.

April 27.—Sir Thomas Henry Holland, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India." Lord Avebury, D.C.L., LL.D., F.R.S., will preside.

May 25.—W. R. H. Merk, I.C.S., C.S.I., LL.D., "The N.W.F. Province of India."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

April 4.—Captain R. Muirhead Collins, C.M.G., "Australia and her Resources."

May 9.—F. Williams Taylor, "Canadian Banking."

Cantor Lectures.

Monday Evenings, at 8 o'clock:—

Professor J. A. Fleming, M.A., D.Sc., F.R.S., "Applications of Electric Heating." Four Lectures.

Syllabus.

Lecture II.—March 13.—"The Appliances and Processes of Electric Heating." Resistance and Arc Heating—Direct and Inductive Methods—Electric Furnaces of Girod, Heroult, Kjellin, Keller, Stassano, Ferranti, Rodenhauser, and others—Resistance Furnaces for Chemical Operations, both at Moderate and Very High Temperatures—Experimental Models.

Lecture III.—March 20.—"The Technical Applications of Electric Heating." The Manufacture of Graphite, Carborundum, Calcium Carbide, Quartz Glass, Aluminium, Ferro-Alloys, and Iron and Steel in Electric Furnaces—Electric Welding—Electric Furnaces for Metallurgical and Chemical Operations.

Lecture IV.—March 27.—"The Domestic Applications of Electric Heating." Electric Water Heating—Its Cost and Economy—Air Heating by Electric Radiators and Convectors—Electric Cooking—Various Systems and Types of Utensil critically discussed—The Advantages and Drawbacks in Comparison with other Methods of Culinary Heating.

ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

May 1, 8, 15, 22.

Dates to be hereafter announced :—

FRANK M. ANDREWS, "Architecture in America."

Professor RAOUL PICTET, "Les Basses Températures."

Sir WILLIAM ABNEY, K.C.B., D.C.L., D.Sc., F.R.S., "The Quantitative Measurement of Colour-Blindness."

HAL WILLIAMS, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

NOEL HEATON, B.Sc., F.C.S., "The Production and Identification of Artificial Gems."

HENRY L. HEATHCOTE, B.Sc., "Wheels, Ancient and Modern, and their Manufacture."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 13...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Dr. J. A. Fleming, "Applications of Electric Heating." (Lecture II.)

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. (Graduates' Meeting.) Mr. A. J. Bremner, "The Balancing of Engines."

Brewing, Institute of (London Section), Criterion Restaurant, Piccadilly, W., 8 p.m. Mr. A. E. Stanley Smith, "Some Responsibilities of Brewers under the Factory Acts."

London Chamber of Commerce, Oxford-court, Cannon-street, E.C., 2.30 p.m. Mr. E. Crammond, "Gold Reserves in Time of War."

Surveyors, 12, Great George-street, S.W., 8 p.m. 1. Messrs. H. F. Bidder and W. Vaux Graham, "Judicial and Parliamentary Decisions with regard to Rights in Underground Water since 1907." 2. Discussion on Mr. W. R. Baldwin-Wiseman's paper, "The Conservation of our National Water Resources."

Geographical, Burlington-gardens, W., 8.30 p.m. Dr. T. G. Longstaffe, "A Pioneer Journey in the Purcell Range, British Columbia."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. J. A. Gotch, "The Burlington-Devonshire Collection of Drawings."

Engineers, Junior Institution of, at the Royal United Service Institution, Whitehall, S.W., 7.30 p.m. Mr. Geoffrey Brooks, "The Design of a Modern Brewery and Plant."

TUESDAY, MARCH 14...Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Discussion on School Lighting.

Asiatic, 22, Albemarle Street, W., 4 p.m. Dr. H. Hirschfeld, "Recent Theories on the Origin of the Alphabet."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. E. H. Tutton, "Crystalline Structure: Mineral, Chemical and Liquid." (Lecture III.).

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Philip Dawson, "The Electrification of a portion of the Suburban System of the London, Brighton and South Coast Railway."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. C. F. Lan-Davis, "Iris Diaphragms."

Faraday Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. 1. Messrs. G. E. Bairsto and R. Mercer, "Some Properties of Aluminium Anode-Films." 2. Messrs. F. P. Burt and R. W. Whytlaw-Gray, "The Weight of a 'Normal' Litre of Hydrogen Chloride and the Atomic Weight of Chlorine." 3. Mr. Ernest Vanstone, "A Physico-Chemical Study of Mercury-Sodium Alloys or Sodium Amalgams." 4. Messrs. S. W. J. Smith and W. F. Higgins, "On Surface Effects between Mercury and Certain Solutions, and an Electro-Chemical Method of Estimating Dissolved Oxygen."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. Mr. Ben H. Morgan, "Empire Trade Relations."

Sanitary Institute, 90, Buckingham Palace-road, S.W., 8 p.m. Dr. Leonard Hill, "Rescue Work in Mines," with a demonstration of apparatus in use.

WEDNESDAY, MARCH 15...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Colonel Charles E. Cassal, "The Adulteration of Food."

Meteorological, 25, Great George-street, S.W., 7.30 p.m. Professor H. H. Turner, "What can we Learn from Rainfall Records?"

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Dr. Ralph Vincent, "The Morphology of the Organisms concerned in the Production of Acute Intestinal Toxaemia in Infants." 2. Mr. F. W. Watson Baker, "Anomalies in Objective Screw Threads." 3. Mr. E. M. Nelson, (*a*) "Some New Objectives and Eye-pieces by R. Winkel, of Gottingen"; (*b*) "An Objective Mount with an Iris"; (*c*) "The Variable Microscope." 4. Señor Domingo Orueta, "Apparatus for Microphotography with the Microscope standing in any Position, especially in Inclined Position."

THURSDAY, MARCH 16...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Mr. Claude H. A. Hill, "Education in India."

National Life-Boat Institution, at the United Service Institution, Whitehall, S.W., 3.30 p.m. Annual General Meeting.

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Linnean, Burlington House, W., 8 p.m. 1. Mr. R. S. Adamson, "An Ecological Study of a Cambridgeshire Wood." 2. Mrs. Scott, "*Traquairia*; an Organism from the Carboniferous Rocks." 3. Miss S. M. Baker, "On the Brown Seaweeds of the Salt Marsh."

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Address by the President, Mr. E. B. Ellington.

Chemical, Burlington House, W., 8.30 p.m. 1. Mr. J. Wade, "Apparatus for the Maintenance of Constant Pressures above and below the Atmospheric Pressure: Application to Fractional Distillation." 2. Messrs. W. G. Prescott and S. Smiles, "The Interaction of Aromatic Disulphides with Sulphuric Acid."

Royal Institution, Albemarle-street W., 3 p.m. Professor Arthur Keith, "Giants and Pygmies." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. J. C. Warburg, "Selection of Autochromes."

Historical, 7, South-square, Gray's Inn, W.C., 5 p.m. Mr. H. E. Malden, "The Holding of Cardigan Priory by Chertsey Abbey."

Numismatic, 22, Albemarle-street, W., 6.30 p.m. Mr. F. A. Walters, "The Stamford Find."

Philatelic, 4, Southampton-row, W.C., 6 p.m. Mr. S. Chapman, "The Early Issues of Mexico."

FRIDAY, MARCH 17...Royal Institution, Albemarle-street, W., 9 p.m. Mr. J. H. Balfour-Browne, "Water-Supply."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. Alwyne Mead, "The Production of Water-Gas."

SATURDAY, MARCH 18...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Radiant Energy and Matter." (Lecture II.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 20th, 8 p.m. (Cantor Lecture.) Professor J. A. FLEMING, M.A., D.Sc., F.R.S., "Applications of Electric Heating." (Lecture III.)

WEDNESDAY, MARCH 22nd, 8 p.m. (Ordinary Meeting.) ARTHUR CHARLES DAVIS, F.C.S., Assoc.Inst.C.E., "The Manufacture of Portland Cement."

CANTOR LECTURE.

On Monday Evening, March 13th, Professor J. A. FLEMING, M.A., D.Sc., F.R.S., delivered the second lecture of his course on "Applications of Electric Heating."

The lectures will be published in the *Journal* during the summer recess.

"OWEN JONES" PRIZES FOR INDUSTRIAL DESIGN.

The Board of Education have issued a notification to the effect that works submitted for the National Competition, and certain other works, are to be addressed to the Secretary, Board of Education, South Kensington, London, S.W. These works include those submitted for the "Owen Jones" Competition.

EXAMINATIONS.

The number of entries for the Society's Commercial Examinations, which commence on April 3rd, is 37,124. The number of centres at which the examinations will be held is 459. Last year there were 33,830 entries from 439 centres.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1911 early in May next, and they therefore invite members of the Society to forward to the Secretary on or before Saturday, April 1st, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, etc.

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (afterwards Sir) Henry Bessemer, F.R.S.

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson (afterwards Lord Kelvin), O.M., LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin.

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

In 1884, to Captain James Buchanan Eads.

In 1885, to Mr. (afterwards Sir) Henry Doulton.

In 1886, to Samuel Cunliffe Lister (afterwards Lord Masham).

In 1887, to HER MAJESTY QUEEN VICTORIA.

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S.

In 1889, to John Percy, LL.D., F.R.S.

In 1890, to Dr. (afterwards Sir) William Henry Perkin, F.R.S.

In 1891, to Sir Frederick Abel, Bart., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S.

In 1892, to Thomas Alva Edison.

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.

In 1894, to Sir Joseph (now Lord) Lister, F.R.S.

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S.

In 1896, to Professor David Edward Hughes, F.R.S.

In 1897, to George James Symons, F.R.S.

In 1898, to Professor Robert Wilhelm Bunsen, M.D., For. Memb. R.S.

In 1899, to Sir William Crookes, F.R.S.

In 1900, to Henry Wilde, F.R.S.

In 1901, to HIS MAJESTY KING EDWARD VII.

In 1902, to Professor Alexander Graham Bell.

In 1903, to Sir Charles Augustus Hartley, K.C.M.G.

In 1904, to Walter Crane.

In 1905, to Lord Rayleigh, O.M., D.C.L., Sc.D., F.R.S.

In 1906, to Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S.

In 1907, to the Earl of Cromer, G.C.B., O.M., G.C.M.G., K.C.S.I., C.I.E.

In 1908, to Sir James Dewar, M.A., D.Sc., LL.D., F.R.S.

In 1909, to Sir Andrew Noble, K.C.B., D.Sc., D.C.L., F.R.S.

In 1910, to Madame Curie.

A full list of the services for which the medals were awarded was given in the last number of the *Journal*.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 15th, 1911; The Right Hon. the LORD MAYOR OF LONDON (Sir Thomas Vezey Strong), in the chair.

The following candidates were proposed for election as members of the Society :—

Eccles, Ernest Edward, M.I.E.E., Foyers, Lochness, Scotland.

Rahder, Christiaan Lydius, LL.D., Sourabaya, Java, Netherlands East Indies.

Ritchie, W. W., District Postmaster, Chengtu, West China.

Sang, Alfred, 96 Boulevard de Versailles, St. Cloud, Seine-et-Oise, France.

Stewart, Professor Louis Beaufort, University of Toronto, Toronto, Canada.

The following candidates were balloted for and duly elected members of the Society :—

Curtis, Miss Gertrude M., 5, Victoria-street, S.W.

Hayward, Johnson, Tuesley Lane Cottage, Godalming, Surrey.

Hebdon, William, 56, Tresillian-road, St. John's, S.E.

Johnston, Edward Hamilton, I.C.S., Terlings, Harlow, Essex.

Willott, Frederic John, The Aluminium Corporation, Limited, Wallsend-on-Tyne.

The paper read was—

THE ADULTERATION OF FOOD.

By CHARLES E. CASSAL.

The subject dealt with in this paper is one of very wide scope, and is surrounded by many difficulties—scientific, legal, commercial and social. Its aspects are many and various, its subsidiary ramifications are widely extended and often highly complicated, and it is impossible, within the narrow limits of a single paper or lecture, to do more than sketch out its main features in a manner that will enable the general public to appreciate their significance and relative importance.

Young and old, rich and poor, in all so-called civilised communities, are affected by the existence of the food-adulteration evil, and, in this country—which, among the nations called civilised, was at one time the pioneer in introducing preventive and repressive legislation, but which has failed to maintain its past leading position—the state of things to-day is such that the formation of a National Society for the Prevention of Adulteration—the Society I am representing here—is not only more than justified, but is absolutely necessary in order that the people may be educated, and that, in consequence, the strong public feeling, without the existence of which effective reform cannot be brought about, may be created.

The history of adulteration presents many features of considerable interest, and I am almost tempted to plunge into the annals of an inglorious past, and to put forward a few of the startling instances of abominable fraud which are to be found in that history. Experience, however, has taught me that when a lecturer on this subject follows that course he runs the risk of being misunderstood unless he takes the most elaborate precautions and makes it perfectly clear that the instances of villainy which he mentions belong to a past age, or are more or less apocryphal. Without those special precautions in the way of elaborate explanation

he is liable to be made responsible for stating that coffee is largely composed of baked horses' livers, that bread is commonly prepared from "putrid and rotten" materials, that moist sugar is heavily adulterated with sand, and so forth. Moreover there are certain persons who wilfully misinterpret the remarks made, and who put them forward, without their context, with the object of making it appear that the advocates of the introduction of more stringent measures for the prevention of adulteration do not know what they are talking about, and that all their statements are exaggerated and unworthy of attention. To those who may be interested in the historical branch of the subject, a perusal of Part I. of Mr. Wynter Blyth's valuable work on Foods* may be recommended. For my present purpose a few brief quotations from that book will be sufficient:—

"Before adulteration commences, commerce must develop. In primitive states of society, there may be knavish tricks, ignorant bartering, substitution of bad for good, falseness and meanness of all kinds, but no systematic sophistication is possible. Again, in the semi-pastoral state . . . in which the food of a family is raised from the soil on which they dwell . . . commercial frauds are unknown or undeveloped."

"There are several notices of ancient sophistication practised by the Greek and Roman traders; but it is from the Middle Ages that the most copious and interesting materials for a history of adulteration are obtained—a page of history but little explored, yet abounding with curious facts more or less illustrative of the manners of the times. The mixing or, rather, alloying of gold and silver with the baser metals may be justly considered as being of the nature of adulteration, and has prevailed contemporaneously with the art of coinage. The well-worn tale of the detection of the base metal in the crown of Hiero by Archimedes, some two and a half centuries before Christ, may be accepted as probably the earliest instance of the scientific detection of adulteration. The process used by the philosopher of Syracuse when thus discharging the duties of a *public analyst* (the determination of specific gravity) is quantitative as well as qualitative, and, though purely physical, is used daily by all engaged in practical chemistry. Pliny, among other matters, alludes to the frauds practised by bakers, for they added to the bread a white earth, soft to the touch and sweet to the taste. . . . The adulteration of wine in Athens necessitated the appointment of a special inspector, whose duty it was to detect and stop these practices. Greek history has handed down the name of one Canthare, who excelled in ingenious mixtures, and knew how to impart the flavours of age and maturity to new wines. His ingenuity was such that it was commemorated in the proverb: 'Artificial as Canthare.' In Rome, also, wine was much tampered with; even the rich, according to Pliny, could not obtain the natural wines of Falerno, for they were adulterated in the cellars, and certain wines from Gaul had an artificial colour given to them by means of aloes and other drugs. . . ."

"In our own country, and in Europe generally, from the eleventh century onwards, the bakers, the brewers, the 'pepperers,' and the vintners, were most frequently accused of corrupt practices. . . . In England the trades of the druggist and the grocer were combined. Drugs and groceries were sold in the same shop, and they were under the same regulations until 1617, when the apothecaries separated themselves from the grocers. Very soon after they had become a distinct body, they began to complain of the frauds and artifices of the grocers. . . ."

The punishments inflicted for the crime of adulteration in past times, in those cases where, with the limited means then available, it was possible to prove the commission of an offence, or, at any rate to prove this to the satisfaction of the authorities, did not err, as a rule, in the direction of leniency as is very generally the case in this country at the present day. It has been suggested that the infliction of some of these punishments might, with advantage, be revived, and I am not sure that as regards certain persons the re-establishment of those punishments might not be beneficial to them and to the community. Mr. Wynter Blyth cites some curious examples:—

"Alan de Lyndseye, baker, was sentenced to the pillory because he had been convicted of baking *pain demayn* that was found to be of bad dough within and good dough without, and because such falsity redounds much to the deception of the people who buy such bread."

This person got into trouble again shortly afterwards—a not uncommon occurrence with adulterators—for we read that:—

"Alan de Lyndseye, baker, and Thomas de Patimere, baker, were taken and brought before the Mayor and Aldermen and sentenced to the pillory for selling bread made of false, putrid, and rotten materials, through which who bought bread were deceived and might be killed.

"It is recorded that in certain cities 'the offender was taken round the town in the cart in which the refuse of the place had been collected,' and that 'to this degradation was often added corporal chastisement.' In Paris, in 1525, a baker convicted of 'false bread' was condemned by the court 'to be taken from the Chatelet prison to the cross before the *Eglise des Carmes*, and thence to the gate of Notre Dame and to other public places in Paris, in his shirt, having the head and feet bare, with small loaves hung from his neck, and holding a large wax candle lighted, and in

* "Foods: their Composition and Analysis." By A. Wynter Blyth. Fourth edition. 1896.

each of the places enumerated he was to make *amende honorable*, and ask mercy and pardon of God, the king, and of justice for his fault.'

"In Germany, during the Middle Ages, it appears that 'those who adulterated foods or drinks . . . were punished severely, with painful and dishonouring penalties, such as public exposure of the fraud and whipping at the gate.' . . . In the fifteenth century, 'in some places the delinquent was put in a basket at the end of a long pole and ducked in a muddy pool.' 'In 1435, the taverner Christian Corper and his wife were put on a cask in which he had sold false wine, and then exposed in the pillory. The punishment was adjudged because they had roasted pears, and put them into new sour wine, in order to sweeten the wine. Some pears were hung round their necks like unto a paternoster.'"

Owing to the inadequate means available for the detection of adulteration up to comparatively very recent times, the few records of detected offences which have come down to us cannot be regarded as in any way representing the extent to which adulteration of all kinds was practised in the past. It is only during the last fifty years that the existence of this monstrous evil has attracted the serious attention of the Governments of civilised countries. The first general Act passed in this country was the Act of 1860. Before that date "individual articles, such as tea, coffee, chicory, beer, and wine, were legislated for by special statutes, the object of which was, for the most part, to prevent the defrauding of the revenue—the health of the purchaser, and the injury done to him, being somewhat less considered, although not lost sight of." In 1850 Mr. Wakley, the then editor of the *Lancet*, established an "Analytical Sanitary Commission," under the direction of the late Dr. Hassall, and, in the first number of the *Lancet* for 1851, the Commission's preliminary report appeared. In 1855 Dr. Hassall collected the articles which had been published in the *Lancet* into a volume entitled "Food and Its Adulterations," and, as a direct result of the campaign initiated by Mr. Wakley and Dr. Hassall, a Parliamentary Select Committee was appointed to consider the whole question in 1855. Upon the report of this Committee the first General Adulteration Act was drafted and became law in 1860. A further Act was passed in 1872; but, as these Acts were not found to work satisfactorily, and as for this reason and other reasons they were ineffective, another Select Committee was appointed in 1874. The report of the Committee led to the passing of the Sale of Food and Drugs Act of 1875, which, with the Amendment Act of 1879, and the subsequent Sale of Food and Drugs and Margarine Acts of 1887, 1899 and 1907, form the existing law.

The state of things existing when the *Lancet* Commission was carrying out the investigations referred to—a state of things which must have been at least as bad before the establishment of the Commission, and which undoubtedly continued to be almost, if not quite, as bad for several years after the publication of the Commission's reports—can best be appreciated by a study of the articles which appeared in the *Lancet* from 1851 to 1854 or of Dr. Hassall's book. It is only needful to observe here that while many forms of adulteration detected at that time have now disappeared, owing to the repressive and deterrent effects of our existing laws—such as they are—laxity and inadequacy of administration and the ineffectiveness of the law in certain directions, lead to the reappearance of some of these older forms of adulteration and encourage the perpetration of new forms of crime even more objectionable, and, in some cases, more dangerous, inasmuch as they are more insidious, more scientific, and far more difficult to detect. Although many of the grosser forms of adulteration detected in past years are now no longer practised, new forms of sophistication are constantly being introduced—very generally under the guise of alleged "scientific improvements," or with the shallow excuse that what has been done has been rendered necessary in order to meet "a public demand," or the requirements of "the public taste." *The adulterator ye have always with you*, and experience leads to the conclusion that the morality of deliberate criminals in the matter of adulteration cannot be held to exhibit any real or substantial improvement in our day. To some extent and in some directions they may have been dragooned into virtue, or into an assumption of virtue, but daily evidence clearly indicates that the evil desire to obtain illegitimate gains without regard for their neighbours' rights, interests, health, or even life, is still existent in their sordid souls, unchanged and undiminished. As affording incontrovertible proof of what I now say, I may direct attention to the records of cases of prosecution under the Food and Drugs Acts which have been published every month in the *British Food Journal* since the commencement of the year 1899 until the present time. Taken as a whole these records constitute what can only be regarded as a crushing indictment—especially in view of the fact that practically all

the cases in question have been recorded because they contain some special point — or some special points—of interest, and represent only a fraction of all the cases heard during the past decade. Assuming the legality of the infliction, during that period, of the ancient punishment previously referred to, which consisted in hanging specimens of the adulterated or defective article round the necks of the condemned delinquents, and in exposing those individuals—after a ride round the town in the dust-cart, and prior to the "castigation at the gate"—in some public place such as Trafalgar-square, or the front of the Royal Exchange, what an edifying spectacle might have been provided for the populace. The necklaces which might have been prepared for the purposes of such an exhibition would have been interesting and very varied in their characters. Bottles of milk containing added water, of milk denuded of fat, of milk containing boric acid or formaldehyde; rolls of "butter" largely or mainly composed of foreign fat or loaded with an excess of water, or containing an excess of boric acid "preservative"; wedges of "cheese" made up with foreign fat or containing next door to no fat at all; pots of "cream" dosed with boric acid; blocks of margarine containing "soft paraffin"; bladders or kegs of "lard" containing generous proportions of beef stearin, cotton-seed oil, or cocoa-nut fat; packets of "coffee" largely or mainly consisting of chicory; tins of "delicacies," such as potted meats and fish, prepared from highly questionable raw materials and duly embalmed by liberal doses of boric acid; bags of meat found to be diseased and unfit and dangerous for human food; fragments of fish, flesh, and fowl, on the verge of putridity, and plentifully sprinkled with boric acid powder for the purpose of masking the signs of decomposition; flasks of "brandy" devoid of spirit distilled from wine; jars of potato-spirit whisky; bottles of lime juice, lemon juice, "cordials," and non-alcoholic drinks plentifully dosed with salicylic acid; and tins or bottles of preserved peas, beans, and spinach well "greened" by the addition of sulphate of copper. The list is far from being exhausted, but it seems unnecessary to go further. The indictment is a long one, and it is much more than sufficient to prove the case.

The term "Adulteration" in the ordinary or popular sense has a restricted meaning. It now possesses a meaning which the word itself does not imply. "Adulteration," *per se*, in its restricted sense, is commonly held to mean the admixture with a given article of some substance foreign to that article, or the addition to that article of some substance naturally present in it, so that the resulting mixture contains an excess of the constituent in question—as in the cases of the addition of water to milk or butter. But it has become convenient, and, in fact, necessary, to give a more extended meaning to the term "adulteration." Under the existing law, an article which exhibits, on analysis, a substantial deficiency in an important constituent—such as a liquid sold as "milk" which is found to contain less than 3 per cent. of fat—must be classed as "adulterated." An article which, in its natural state, normally contains an impurity, the presence of which is due to the conditions of production or collection, becomes "adulterated" if the amount of that impurity is found to be substantially in excess of a particular limit—as in the case of the presence of sandy matter in pepper. Again, owing to the variations in the compositions of natural products, it is not always possible to draw a rigid line of demarcation between the genuine and the adulterated article. There is a borderland of varying extent in different cases, and the operation of definitely placing a given article on one side of that borderland or on the other is often a matter of extreme difficulty. One result of this is that in regard to all natural products the most lenient limits and standards must be adopted in order that no injustice may be done to the manufacturer, producer, or vendor, in the administration of the Acts of Parliament, which are, in reality, criminal Acts. In this country there exist, as yet, practically no definitions having the force of law as to what is to be held to constitute "adulteration" in the cases of a great many articles. Each case brought before the courts has to be fought out on its merits, and conviction, or dismissal of the charge made, must depend on the evidence adduced and on the effect produced by that evidence on the mind of the adjudicator. In some countries, notably in the United States, and in one or two of our Colonies, the authorities have gone a long way ahead of us in this matter. In the United States the accepted view has been formulated thus:—

"Except in special cases, a food in general is deemed to be adulterated if anything has been mixed with it so as to reduce or lower its quality or strength; or if anything inferior or cheaper has been substituted wholly or in part therefor; or if any valuable constituent has been abstracted wholly or in part from it; or if it consists wholly

or in part of a diseased, decomposed, or putrid animal or vegetable substance; or if by colouring, coating, or otherwise it is made to appear of greater value than it really is; or if it contains any added poisonous or injurious ingredient." *

This definition is fairly satisfactory so far as it goes, but it is insufficient in extension. The main principle on which our Sale of Food and Drugs Act of 1875 is based should be included in it, namely, that under any circumstances an article shall be deemed to be adulterated if it can be proved that that article is not of "the nature, substance, and quality" demanded by the purchaser, or if it is not of "the nature, substance, and quality" which the purchaser is to be presumed to have expected.

In Great Britain and Ireland the administration of the Food Adulteration Acts is in the hands of the local authorities—the borough and city councils and the county councils. Under the provisions of these Acts the local authorities are not only empowered, but are required to appoint persons of knowledge, skill and experience as public analysts, whose duty it is, in consideration of such remuneration as may be agreed upon, to analyse samples of foods and drugs submitted to them by inspectors specially appointed under the Acts to take samples of articles exposed for sale, or submitted by private purchasers who have complied with certain conditions laid down in the Act of 1875. Within a specified time the public analysts are required to issue certificates showing the conclusions at which they have arrived in regard to the nature of the samples submitted to them. Up to the present the onus of advising the local authorities as to whether a given sample is, or is not, adulterated has rested entirely on the shoulders of the public analysts, and this ought not to be. It was, and it is, the duty of the Government for the time being to carry out, and to bear the expense of carrying out, the necessary investigations; and, on the results of those investigations, to lay down directions and regulations for the proper and effective administration of the Acts. It is satisfactory to be able to say that the truth of this principle has, at length, been recognised. Within the last few years a new department has been established at the Local Government Board—the Department of the Inspector of Foods—under the able direction of Dr. G. S. Buchanan. This department has already done a great deal of excellent work, and it may be confidently expected that it will do a great deal more. Unfortunately arrangements do not yet appear to have been made—in so far as the Food and Drugs Acts are concerned—whereby the recommendations made by the department may be given the force of law.

The Board of Agriculture and Fisheries now possesses powers to make regulations and to lay down limits and standards in regard to certain articles of food such as milk, cream, butter and cheese, and has exercised those powers with respect to milk, to separated and skimmed milk, to butter; and also with respect to so-called "milk-blended butter" in so far as the allowable percentage of water is concerned; but the Board has recently declined to accede to requests, put forward by various borough councils, to the effect that the Board should lay down standards and limits for fat, water, and other constituents for the different kinds of cheese sold in this country.

The solution of the difficulty of deciding what is and what is not to be regarded as constituting "adulteration" is, I think, the establishment of a properly-constituted Court of Reference—as recommended by the Food Products' Adulteration Committee of the House of Commons in 1896—which would act in concert with the Foods Department of the Local Government Board, and with the Board of Agriculture should necessity arise. In reporting on this matter the Committee of the House of Commons made the following statements, *inter alia*:—

"Your committee think that the question of the practicability and expediency of fixing food standards should receive the consideration of a specially constituted scientific body familiar with questions of analysis and the chemistry of food, and they recommend that such a body should be established . . . The Court of Reference constituted on the lines indicated should be empowered to make such orders as they think proper respecting standards of the quality and purity of food, and such orders should, when confirmed by a Secretary of State, have the force of law. It appears to your committee preferable to fix standards in this way than by means of an Act of Parliament. The former course would more readily admit of the alteration of a standard if for any reason such a proceeding were found desirable . . . The proposed Court of Reference should be entrusted with the duty of collecting and communicating to public analysts and others information as to new and unrecognised forms of adulteration, and also of examining and pronouncing upon new methods of analysis."

I concur in these views. In fact I may now say that the evidence upon which the portion of the Committee's Report relating to the establishment of a Court of Reference was founded, although not actually given before the

* "Food Inspection and Analysis." By Albert D. Leach. New York: 1904.

Committee by myself, was put forward mainly at my instance. It is not to the public interest that scientific officials who have to carry out such duties as those of a public analyst should have the heavy responsibility of deciding what is and what is not to be regarded as constituting "adulteration" thrown upon them. It is not fair and it is not reasonable that individual public analysts should be compelled to carry out lengthy and expensive scientific researches —which they have neither the time nor the means to carry out—and that they should find themselves repeatedly compelled to do this simply because successive Governments have shirked their responsibility and have not taken the necessary steps to have these matters studied at the Government expense. Under existing conditions the public analyst is placed in a very false and a very difficult position. He may have issued a certificate—based upon what knowledge he may have been able to gain in regard to the article dealt with—the terms of which indicate to his authority that an offence has been committed. He has to defend that certificate in a Court of Law—probably in the face of powerful opposition, and of a defence, in the preparation of which no expense has been spared. He is frequently subjected to an insulting cross-examination--in the course of which his good faith and his professional capacity are generally called in question—and he has to prove his case to the satisfaction of the presiding legal luminary who, while no doubt learned in the law, cannot always be expected to be learned in anything else. In the absence of legal standards and limits and of accredited technical advisers to the Bench, cases involving most difficult and recondite scientific points are sandwiched between cases of assault and petty larceny, and have, under our present system, to be threshed out in police-courts at great expense both of time and money; and, unless he possesses some sort of scientific knowledge, the unhappy magistrate is compelled to rake up from a dim and distant past the shadowy recollections of his school chemistry, and to struggle with little arithmetical problems which it is not always fair to expect him to deal with. Recent striking examples of our cumbrous and unsatisfactory course of procedure are afforded by the Court fights over boric acid in cream, "cornflour" consisting of rice starch, silent spirit in brandy and whisky, and cocoa shell in cocoa, some of which have led to the appearance of the newspaper head-lines, "What is Brandy?" "What is Whisky?" "What is Cocoa?"—questions which, in spite of all the trouble and expenditure involved in considering them, have not as yet been settled by any finally binding decisions, or by any authoritative pronouncements from a Governmental source.

The more common forms of food adulteration which come before the Public Analyst at the present day may be briefly mentioned here. *Milk*:—(1) The addition of water. (2) The abstraction of fat (*a*) directly by surface skimming, leaving the liquid known as "skimmed milk," or (*b*) by the use of a centrifugal separator, whereby practically the whole of the fat can be removed, leaving the liquid known as "separated milk"; or (*c*) indirectly by the admixture of separated milk with whole milk. (2) The addition of water and the abstraction of fat. (3) The addition of "preservative" chemicals or drugs, such as boric acid and borax or mixtures of these two substances, or the solution of formaldehyde, known as "Formalin"—a most powerful and dangerous substance—or some other chemicals. (4) The addition of colouring matters, many of those now used being of coal-tar origin—a proceeding which serves the purposes of fraud by giving a false appearance of richness to the milk and by deluding the purchaser accordingly. (5) The production of deficiencies in the normal constituents of milk by the improper feeding or the improper management of cows, whereby milk having the same composition as milk directly adulterated with water or directly deprived of a portion of the fat, may be yielded. This proceeding may justly be regarded as "adulteration at the other end of the cow" and should be looked upon and treated as an offence.

Butter.—(1) The admixture of "foreign fat," that is, the admixture with genuine butter of a fat or fats not having the composition and characters of butter fat. This is generally accomplished by mixing "margarine"—a substance prepared in imitation of butter from the fat of cattle—with the butter. Cocoa-nut oil is now largely used for the adulteration of butter, and is very generally used in conjunction with animal fat. (2) The incorporation of an excess of water with butter. (3) The addition of "preservative" chemicals, generally boric acid or borax, or mixtures of the two.

Cream.—(1) The addition of preservative chemicals, generally boric acid preparations. (2) The use of certain preparations for the purpose of giving a thick appearance to cream (gelatine and so-called "sucrate of lime"). This,

however, is at present a rare occurrence. Cream is now largely prescribed by medical men for children and invalids.

Cheese.—(1) Deficiency in fat owing to the use of separated milk or skimmed milk in the manufacture, the deficiency not being permissible if the article is not sold as "separated-milk-cheese" or "skimmed-milk cheese." (2) The presence of foreign fat—fat other than milk fat, the cheese having been made from separated milk and animal fat. (3) Excess of water. (4) In the case of certain cheeses sold as "gorgonzola" the attachment of artificial rinds composed of barytes and tallow.

Lard.—(1) Presence of water. (2) Addition of beef or mutton stearin. (3) Addition of cotton-seed oil. (4) Addition of vegetable fats, such as cocoa-nut oil or palm-nut oil, or substitution of these for genuine lard. (5) Addition of paraffin wax and "soft paraffin."

Tea.—(1) Presence of exhausted and redried tea leaves. (2) Presence of leaves foreign to tea. Although it is possible that these forms of adulteration are still practised, the number of samples of tea taken under the Acts is comparatively so small that no definite conclusions are possible. No cases have been recorded for several years.

Coffee.—The addition of chicory or other roasted foreign vegetable substances.

Cocoa.—(1) The addition of starch foreign to cocoa—such as sago-starch, potato-starch, and arrowroot, the mixture being sold as "cocoa." (2) The addition of sugar. (3) The addition of the powdered shell of the cocoa-bean.

Chocolate.—(1) The use of cocoa containing cocoa-shell, or the substitution of cocoa-shell for cocoa in the manufacture of the article. (2) The addition of foreign starches. (3) The addition of foreign fats.

Brandy.—(1) The substitution of coloured and flavoured silent spirit, or the adulteration of genuine brandy with silent spirit—in other words, with "plain" alcohol produced from any raw material from which it can be obtained by chemical processes. (2) The addition of water.

Whisky and Rum.—(1) Adulteration with silent spirit or substitution of coloured and flavoured silent spirit for the genuine article. (2) The addition of water.

Bacon, Ham, Poultry, Fish.—The addition of preparations of boric acid.

Preserved or Potted Meats and Fish.—The addition of preparations of boric acid.

Preserved Green Vegetables (peas, beans and spinach).—The addition of sulphate of copper for the purpose of imparting an artificial green colour to the articles.

Vinegar.—(1) The addition of water. (2) The addition of mineral acids. (3) The substitution of coloured solutions of "wood acid" for malt vinegar.

Mustard.—(1) The addition of wheat flour and turmeric powder. (2) The abstraction of mustard oil.

Pepper.—(1) The presence of an undue amount of sandy matter. (2) The addition of rice flour or rice starch or other foreign starch. (3) The addition of ground woody material, such as ground olive stones.

Lemon Juice, Lime Juice and Non-Alcoholic Drinks.—The addition of salicylic acid—a powerful and dangerous drug—for "preserving" purposes.

Beer.—(1) The addition of water. (2) The addition of saccharin. (3) Contamination with arsenic. In bottled beers, the addition of salicylic acid.

Wine.—(1) The addition of water. (2) The addition of salicylic acid. (3) The addition of sulphurous acid or compounds thereof. (4) The use of coal-tar dyes or other forms of artificial colouring matter.

Confectionery.—(1) The addition of paraffin wax. (2) The use of ferruginous earths for colouring. (3) The use of coal-tar dyes for colouring. Many of these dyes are known to be poisonous, while as to others little or nothing is known in regard to their possible effects on the consumer.

Tinned Foods.—(1) Contamination by tin and lead. (2) Unwholesome or partly decomposed condition.

Jams and Preserves.—(1) The use of starch-glucose instead of cane or beet sugar. (2) The substitution, in whole or in part, of one fruit for another. (3) The addition of salicylic acid.

Rice and Barley.—Coating the grains with powdered talc ("French chalk").

The foregoing statement is only to be regarded as a sketch. It would be wearisome to enter into further details in this direction, but some observations on certain points are desirable.

The addition of chemical "preservatives" to articles of food is a most objectionable practice, which has enormously increased of late years. The substances used consist principally of boric acid, borax, and mixtures of these two substances; salicylic acid, formaldehyde, and sulphurous acid and sulphites. The addition of these drugs to foods in any quantities, however small, is absolutely indefensible. Serious

injury—particularly to those who are specially susceptible to the action of these substances, or whose digestive and excretory organs are in any way impaired—must and does result. It must be borne in mind that these substances are added to a great number of foods, and that the contention of some defenders of the practice that a single small dose of boric acid or salicylic acid is harmless to healthy persons is beside the mark. Boric acid, for instance, is extensively used in all sorts of food. As already indicated, it is to be found in butter, cream, meat (including bacon and ham), fish, poultry, preserved meat and fish foods, and other articles, so that it is quite possible that in the course of a single day a consumer of these articles may take in a heavy dose of the drug.

Boric acid and compounds of boric acid and salicylic acid are drugs. Formaldehyde and sulphurous acid and sulphites are poisons. They are not foods in any sense. They are not natural constituents of milk, of butter, or of cream or meat, or of any other foods.

Boric acid and compounds of boric acid, salicylic acid, formaldehyde, and sulphurous acid, are added to foods for the purpose of arresting the progress of decomposition for a time, and, particularly as regards boric acid, for the purpose of masking or hiding the evidences of commencing or progressing decomposition. By the use of these preservatives it is possible to make a food in which decomposition has proceeded up to a certain point appear fresh to the ordinary observer, when it is, in reality, not fresh; and a vendor may thus be able to "palm off" stale or turning foods as fresh and wholesome foods.

The use of chemical preservatives is not necessary "for the production or preparation of foods as articles of commerce." Proper preparation, refrigeration properly applied, and cold storage are the methods which should be adopted for the preservation of foods for such periods as may be regarded as legitimate.

The practice of adding drugs or chemicals to foods is adopted by certain manufacturers and vendors largely for the purpose of avoiding the expense attaching to the provision of proper appliances and of adequate assistance to ensure cleanliness and reasonable preservation without the admixture of such drugs and chemicals. To allow the use of the latter is to encourage the employment of dirty and dangerous methods.

The addition of drugs and chemicals to foods is not excusable on the plea that, by this course, preservation, or *apparent* preservation, is obtainable for a longer time than when such drugs are not used. The keeping of articles of food for lengthy periods before use by endeavouring to prolong their "lives" beyond the natural limits with the aid of drugs is highly objectionable, and is necessarily always attended with danger to the consumer owing to the possible and, in fact, probable development and production of poisonous substances of a virulent character in the food by lengthy keeping.

On scientific, and particularly on chemical, grounds, and quite apart from the medical aspects of the subject, the presence of chemical preservatives in foods, in amounts sufficient to exert their specific "preservative" or "antifermentative" action on such foods, must, of necessity, interfere detrimentally with the processes of natural digestion of such foods, and, in so far as the "preservative" or "antifermentative" effects can be exerted by the drug present, so far are the chemical processes of digestion inhibited, retarded, or otherwise injuriously affected.

The adulteration of preserved green vegetables —such as peas, French beans and spinach—with sulphate of copper is a particularly abominable practice. The salts of copper are virulent poisons and many persons are specially susceptible to their effects. It is extraordinary that there are people to be found—some of whom ought to know better, and some of whom must know better—who endeavour to excuse this proceeding. It is commonly contended on behalf of the defence in cases of prosecution for the offence in question, as well as in cases of prosecution for the admixture of chemical preservatives with articles of food, that there is not adequate evidence to show that consumers have suffered definite injury to health by the ingestion of the "doctored" products. Without the actual exhibition of "awful examples" in court it is, of course, extremely difficult to prove injury of this kind by the production of specific cases. Surely the introduction into a food of some substance the physiological effects of which— apart from its effect on the food itself—may, in the opinion of some few people, be doubtful, is bad enough, but when we come to the introduction of known poisons into food the fact that there are some persons to be found who will try to excuse such a practice is somewhat startling. I may mention that no less than three cases of violent copper poisoning, unquestionably due to the ingestion of preserved

peas containing sulphate of copper, have come under my personal observation during the past few years. Another statement commonly made on behalf of the defence in cases of sulphate of copper adulteration is that the copper salt is added for the purpose of "preserving" the natural colour of the vegetable. As a piece of barefaced impudence this statement is certainly worthy of admiration. As a matter of fact the colour obtained is not the "preserved" colour of the vegetable, but is a false colour due to the presence of the copper salt and is the colour of a compound of copper.

I have no intention of entering at length into the great beer question. It will, I think, be sufficient to point out that the innocent "man in the street" is still under the erroneous impression that when he buys beer he is necessarily buying a liquid prepared from barley-malt, hops, and water. The beers produced by some brewers still conform to this requirement, but the permission given by a paternal Government to introduce what is known as the "free mash-tun" has resulted in the use of enormous quantities of sugars and of "substitutes" for barley-malt—a course of procedure which is stated by some of the representatives of the brewing industry and by some of their distinguished scientific advisers to have resulted in great advantage to the public. One of the advantages conferred on the public by the "freedom" alluded to was the extensive outbreak of arsenical poisoning which occurred a few years ago, mainly in the North of England and in the Midlands. Starch-glucose is a saccharine substance obtained by the action of sulphuric acid on any starchy material; the mineral known as pyrites—which contains arsenic—is used as a source of sulphur in the manufacture of sulphuric acid. If the sulphuric acid is not properly purified it is liable to contain substantial proportions of arsenic; arsenical starch-glucose, prepared by the use of arsenical sulphuric acid, was used, no doubt quite innocently so far as knowledge of the presence of arsenic was concerned, in the manufacture of certain beers, with the result that the drinkers of the beers developed the symptoms of arsenical poisoning, and in addition to many cases of illness and recovery, a number of lives were lost. The story is pretty and instructive, and in connection with that story it is advisable to bear in mind that starch-glucose is extensively used in the preparation of several other articles of food. I do not allege that the starch-glucose so used is arsenical. I merely point out the risk attaching to the use of this material without the absolute certainty that it is free from arsenic. I have only to add that starch-glucose—of course, not necessarily arsenical—is extensively used in the manufacture of certain kinds of confectionery, in the manufacture of certain liqueurs, and as an adulterant in "golden syrup."

Not very long ago it rather suddenly struck various people, both here and abroad, that when a purchaser asks for brandy he is entitled to receive a spirit distilled from fermented grape-juice or wine—distilled in a particular way and by the use of a particular form of apparatus. Inasmuch as genuine brandy has been made for centuries in this manner, and as its peculiar characters and its remarkable medicinal value, in cases where its administration is required, depend on the fact that it is so produced, it became necessary to ascertain whether, by analytical means, brandy properly derived from wine, and therefore genuine, could be distinguished from the factitious article consisting of "plain" or "silent" spirit, coloured and flavoured to resemble true brandy. Within certain limits this was found to be possible—not in all cases, but in many—with the result that several prosecutions for the sale of factitious brandy as "brandy" were instituted by various local authorities. The matter is plain enough—like the spirit used—but strange to say, some distinguished scientific experts of my acquaintance have managed to persuade themselves that *any* alcohol, in whatever way and from whatever raw materials it may have been produced, coloured and flavoured in imitation of real brandy, is to be regarded as "genuine" brandy. By what processes of reasoning my learned friends have managed to arrive at this conclusion I have been unable to discover. I can only say that, in my opinion, their contention is wholly indefensible and ridiculous. In spite of the prosecutions and of the convictions obtained, factitious brandies still masquerade on the market as genuine brandies, to the general detriment of the public and to the grievous injury of some whose chances of "turning the corner" in the peril of sickness may depend on the timely administration of the special stimulant in question.

As already stated, the adulterator is ever with us, and the appearance of new forms of adulteration in itself affords proof of the truth of this statement. A few years ago this country received large consignments of flour from America, such flour being adulterated with

from 5 to 10 or 15 per cent. of maize. Where the profit came in I do not know, but there can be no question that if there was no profit in the operation it would not have been carried out. Very recently a process for bleaching wheat flour has been introduced, which essentially consists in exposing the flour to the action of the oxides of nitrogen commonly known as "nitrous fumes." This process, to which the descriptions "electrical treatment" or "ozonised air treatment" have been imaginatively applied, injuriously affects one of the constituents of flour—the gluten—and has been shown to result in leaving undesirable impurities in the shape of nitrates and nitrites in the flour, and even in the bread made from it; while the effect produced on the gluten must unquestionably diminish the nutritive value of the bread. Another highly objectionable form of adulteration as regards wheat flour, which, so far as I know, has only quite recently been introduced, consists in the addition of acid phosphate of lime. This substance is produced from bones, and the process employed in producing it is anything but æsthetic. Here, again, in view of the methods which must necessarily be used, there is grave danger of arsenical contamination, and, in point of fact, this form of adulteration, which is stated to make the flour "go farther" in the production of bread, amounts to the introduction into bread of objectionable extraneous mineral matter of a possibly dangerous type.

I do not propose to enter into a consideration of the subject of "Standard Bread," to which the *Daily Mail* is now so effectively calling public attention. This matter is, in reality, outside the scope of my paper, and I merely confine myself to the statement of my opinion that the system of making bread from flours produced by milling processes which result in the removal of much of the valuable nutritive matter contained by the whole-wheat grain, is a system which has probably been the cause of much injury to the people, which can only be the cause of further injury if its application is persisted in, and which must be condemned accordingly.

There are many other facts and many other considerations which might properly be mentioned in a paper of this kind, but I know that any attempt to set them out would lead me too far. The fallacious and misleading statements which are commonly put forward for the purpose of defending or condoning various forms of adulteration are legion, and I should like to dissect them all and to expose their true nature to the public gaze. One fallacy I will allude to before concluding. This is the fallacy, industriously circulated by certain persons, that the annual reports of the Local Government Board on the working of the Food Acts may be taken to indicate a substantial yearly diminution in adulteration and a general improvement in commercial morality. The reports in question do not justify that conclusion. So long as in many boroughs and counties the Food Acts are dead letters, or are administered by authorities some of whose influential members, for reasons best known to themselves, approve of, and advocate a policy of, "*laissez-faire*," no accurate conclusions as to the extent to which adulteration prevails can be drawn from the official reports in question. The Board can only report on the information it receives. Our food laws—such as they are—have undoubtedly produced, and are still producing, very beneficial effects. But those laws are cumbrous, unwieldy, unnecessarily complicated, and exceedingly difficult to administer effectively. It is necessary that they should be recast into one strong and comprehensive law, framed in the light of all the scientific, legal, technical, and commercial knowledge and experience that may be available, comprising those provisions of the existing Acts which have been found to be beneficial to the public, and such new provisions as may be necessary to secure a vigorous, uniform, and effective administration; as well as the adequate protection and, I may add, the adequate remuneration of the officials whose duty it is to carry out the requirements of the law. The one central principle upon which all such laws must be founded is the main principle of the Act of 1875—that the purchaser shall receive the article which he has demanded, or which he must be presumed to have demanded. Although, having regard to the low standards and limits which must, perforce, be adopted, repressive legislation can never ensure the universal supply of foods of high quality to the public; although, in fact, repressive legislation, while tending to prevent the more serious forms of adulteration, must, of necessity, result in many cases in legitimatising the supply of inferior products, a law, framed with the central principle referred to constantly in view and devoid of the various loopholes and back doors for the escape of offenders which are the blots on the existing Acts, must be productive of enormous advantage to the people at large as well as to the honest manufacturer and trader.

DISCUSSION.

The CHAIRMAN thought all present would be agreed upon the importance of the subject that had been so ably dealt with in the paper, and impressed with the masterly way in which that subject had been presented to them. The lecturer appeared to have discovered that adulteration of some sort and in some degree had been common to all ages, and that in that respect the present generation were merely repeating history. Colonel Cassal had rightly shown that wherever and whenever adulteration had been committed, injury to the people had followed that departure from strict commercial morality. He (the Chairman) had the honour to represent a certain small area in London—but he thought he could claim, although small, important—where a leading part had always been taken in the movement of resisting the adulteration of the people's food. The Corporation of London, which he especially represented, had throughout their history taken an active part in enforcing the laws of the land in the protection of the people; and they had been associated with a number of City Companies, or Trade Guilds, which for centuries had found their chief employment in maintaining in the interests of the people good workmanship and pure materials—a combination which produced the article a purchaser expected to receive when he made a demand for it, or, in the words of the Act quoted by Colonel Cassal, "must be presumed to require." Those old City Companies, such as the Bakers, the Goldsmiths, and the Vintners, to which reference had been made in the paper, had laboured century after century, no doubt not entirely without regard to their own individual interests, but largely in the protection of the public against the fraudulent dealer. For instance, he remembered that the butchers had a very effective by-law to enforce punishment upon those who persisted in disregarding their moral responsibilities. If a butcher was discovered selling impure or putrid or diseased meat, the joints complained of were taken before a predecessor of his (the Chairman's) and if found to be defective, condemned. The man was then taken away to the pillory, and with him the defective meat. After he had been secured in the pillory the meat was placed under his nose and set on fire, so that the man should have the leisure of his enforced idleness to contemplate the wickedness of his act, and be at liberty to inhale the evidences of his villainy in selling what was impure and unworthy of consumption. He merely mentioned that to show how the little community he had the honour to represent had always been alive to the importance of the subject so admirably dealt with by the paper. The lecturer had spoken of the early adulteration of gold and silver. There again, if a person wanted to be quite certain that he was buying gold and silver, he at once looked for the stamp known as the hall-mark, which hall-mark was impressed by the Goldsmiths' Company—a Company that had been formed in the twelfth century to insist upon dealers in gold and silver giving to the purchaser of their goods the article for which he asked and the article for which he paid. Colonel Cassal also spoke of wines and spirits. Personally, although he did not put it forth as a matter that should receive legal commendation, he always thought wines and spirits, if adulterated with a no more injurious article than water, were rendered the more healthy by the greater adulteration! But that was merely a personal eccentricity of his own. He had simply mentioned one or two matters to indicate that the old City had long taken an interest in the subject under discussion, and the policy of the Corporation was to pursue a similar course in the future. The Corporation kept its inspectors, not in their offices, but going about all day long into shops in the City of London—into coffee and milk-shops as well as into wine and beer-shops, where, by making purchases through agents supposed to have no official standing in the City, they were able to test from time to time whether the citizens of London really got what they paid for and what they were entitled to receive. The Corporation's inspectors were even making inspection in regard to slices of bread and butter, so that the poorest of the poor should not be defrauded in the very food upon which their life and good health depended.

Mr. CHARLES S. GOLDMAN, M.P. (Chairman of the National Society for the Prevention of Adulteration), said all who had heard the very searching and instructive paper would agree that too much attention could not be bestowed on the question of food supplies, and above all on the purity of food in order to secure, as far as it was possible, immunity from the frauds which beset the population. Colonel Cassal was one of the most formidable forces against the sophistries and wiles of those who were committing acts of adulteration of foods, but at the same time both his friends and his opponents had to acknowledge that one of his chief characteristics was a desire for fair play towards all. Turning to the question of adulteration, he (the speaker) thought it was unfair to assume that because distressing symptoms did not manifest themselves immediately on the ingestion of either drugged or adulterated food, or food of an unwholesome character, the victim suffered no wrong. There were many records of human suffering as the result of adulteration, and none worse than in the case of infants. In spite of all the improvements in hygiene and preventive medicine introduced by Lord Lister and others, there was an alarming and increasing rate of infant mortality in this country which must be largely ascribed, as far as could be judged, to the primary conditions of infant life. That being the case, it was most necessary that the milk supply of this country should be carefully watched, and it should be seen that infants were given wholesome food. The question of adulteration, so intricate in its character, could, in his opinion, only be dealt with on

a large scale. It would be an insult to manufacturers to suppose that they were not sensible of the existence of the frauds that were being committed, and that they were not as anxious as anybody to detect those who were committing such frauds. What was necessary at the present moment, in order to prevent much of the dissipation of energy that was going on, was to try to organise the action of the two sections—the trades and the people. Colonel Cassal had already mentioned a Court of Reference, and he (the speaker) thought that was no impossible solution of the whole difficulty. He would venture to suggest that three panels might be formed, one panel consisting of the organised societies dealing with the particular question, one panel consisting of the manufacturers, and one panel consisting of neutrals, all trying to arrive at certain standards by which the food supplies of this country should be acknowledged and recognised. He thought if such standards were laid down, it would be found that the trades were ready to respond to such formulæ, and automatically would form a boycott against those who were unwilling to conform to the findings of the Court of Reference.

Mr. F. J. Lloyd said, as an analyst in the City of London for thirty years, he had had an opportunity of learning something about the adulteration which was taking place, not only in articles of food, but, he was sorry to say, in a great many other articles which were sold in this country. He was also Consulting Chemist to the British Dairy Farmers' Association, and therefore had had an opportunity of looking at some of the problems of adulteration from the point of view of the producer and manufacturer of articles of dairy produce which were so frequently sampled under the Sale of Food and Drugs Act, and which were so often the cause of litigation. He ventured to think it was very necessary to consider both sides of the question, especially with regard to the presence of preservatives in food. It must be remembered that in the enormous City of London, supplies of food were obtained from very great distances, and had to be produced many hours before they could be delivered and consumed, and it was a very great problem which the medical profession and the analyst and the public had to consider, as to whether it would be better to preserve that food to a certain extent from decay or to have it delivered in an incipient state of decay which perhaps it was not possible to estimate or to understand. He thought himself there would be a far larger amount of ptomaine poisoning if the use of preservatives of every description was totally prohibited. On the other hand, he protested against the illegitimate or unnecessary use of preservatives, and against the use of any article which was undoubtedly injurious to health, but in his opinion a happy medium was required; extremes should be avoided. He was also on the Committee for the Prevention of Fraud, appointed by the Chambers of Agriculture, which committee had to consider the question of adulteration, not only as affecting food but as affecting a great many other articles bought and sold in this country, and they had arrived at the conclusion, and had passed a very strong resolution—which had been universally supported by all the Chambers of Agriculture in the country—calling upon the Government to appoint a Court of Reference, as to which Colonel Cassal had so strongly spoken. He (the speaker) believed it was essential that the Government should appoint such a Court of Reference to lay down standards which on the one hand would enable the public analyst and the analyst generally to carry out his work with more certainty, and on the other hand would protect the consumer and the producer of the articles which were sold in this country. There was another point upon which he thought himself compelled to touch. It was, he thought, the expression of extremist views—especially by the reader of the paper and the medical profession—which had done a great deal to prevent, rather than to facilitate, the progress which everyone desired.

On the motion of the Chairman, a hearty vote of thanks was accorded to Colonel Cassal for his paper.

Colonel Cassal, in reply, said he did not think it was necessary to take up any time, as no questions had been put to him. With regard to his friend, Mr. Lloyd, he could have dealt with him at length if it had been necessary, but he did not think it was. Mr. Lloyd advocated a mild form of procedure and he (Colonel Cassal) did not: but on the main point, the establishment of a Court of Reference, they were agreed.

Mr. Waldorf Astor, M.P., had the greatest pleasure in conveying the thanks of all present to the Lord Mayor for presiding over the meeting. The audience were very grateful for his presence and the interest that he took in the movement for improving what he (the speaker) might describe as that most important national asset—physical welfare. Whether the society to which the lecturer belonged confined its efforts purely to protecting the public from adulterated and injurious foods, or whether they added education in food values, it was quite evident that the improvement of the physique and the digestion of the country would ultimately increase the happiness of the people. It was not necessary to have lived surrounded by hungry children or in contact with the typical choleric dyspeptic retired colonel of the novelist to know that good nutrition and good digestion meant increased happiness. The Chairman had referred to what he modestly described as a personal eccentricity; he might have told the audience that he had succeeded in doing what was exceedingly difficult in the present day, namely, establish a record —for

he was the first total abstainer to occupy the distinguished position of Lord Mayor of London. The position which alcohol in moderate quantities was to hold in regard to medicine had not yet been fixed and decided upon by men of science, but, whether the principles of the Chairman were agreed with or not, everybody had to admire one who had set out with an ideal and who, by abstinence, strength of character, and strength of purpose, had consistently carried out to the best of his ability that ideal.

Sir JOHN LAMB, on behalf of the Council of the Society of Arts, also welcomed the Lord Mayor and thanked him for his presence on this occasion. They knew how many engagements he had, and how difficult it was for him to fulfil them all.

The CHAIRMAN, in reply, said it had been a great pleasure to him not only to hear the able paper, but to be allowed to come into that hall and associate himself for the first time in his life with the Society, the records of which he had followed with much interest and instruction for many years. He was exceedingly pleased to find himself in a temple which, in his mind, he had always classed as classic ground. The Society had a long and illustrious history, and he could only hope that there remained for it in the future a part as distinguished, as honourable, and as instructive as its great past.

ARTS AND CRAFTS.

Wall-papers and Printed Cottons.—The new designs for wall-papers and printed cottons seem to be making their appearance rather earlier than usual this year. The most noticeable thing about the cretonnes is the number of patterns which are directly founded on old crewel embroidery. It seems to be essential that the more important patterns should look like something else rather than like printing. If they do not imitate needlework, they must at least do their best to simulate weaving. The one great exception to this rule is in the case of the Early Victorian designs of a so-called "naturalistic" type, which certainly have the merit of not pretending to be anything but what they are—ugly as they may be. An increasing number of wall-papers are produced on a black ground—recalling the period when an English version of Eastern, and especially Chinese, work was all the rage. Some of the designs on this sombre ground are, however, more nearly akin to seventeenth-century English needlework than to Oriental patterns. Again, the colouring of a good many of the wall-papers suggests the rather dumb tones of a certain kind of tapestry hanging rather than printed paper. The empty, open designs of a few years ago are a thing of the past, the once popular stripe has modestly retired into the background, and the sprig and spot patterns have vanished, except in cases where they reappear on the background of a well-covered all-over pattern of a neutral tint which, though it is sometimes quite elaborate, does little more in the distance than form a sort of broken colour effect. It is the fashion for wall-papers as well as printed cottons to pretend to be something other than they really are. Plain lining papers are, of course, still being used, often finished off, when they are hung, with a heavily-patterned frieze—but there are an increasing number of papers on the market which are meant to look like various other materials; some of them, evidently intended to be arranged in panels, are even got up to represent leather. There is little that is strikingly new in design; in fact, the prevailing fashion neither demands nor welcomes anything to which the salesman cannot, by no matter how great a stretch of imagination, attach the name of some well-known period. What is remarkable is the wealth of pattern which is being used both in wall-papers and chintzes. Whereas a couple of years ago no one seemed to want pattern at all, to-day the cry is for as much as can possibly be crowded into the space. The result at present, though there are a few good designs about, can hardly be said to be wholly satisfactory, but it is to be hoped that the fact that repeating pattern is in such demand will encourage designers to work with greater zeal, and will recall to the student, who has almost ceased to look upon design as a possible calling, the fact that there is such a thing as the art and craft of pattern design.

Art and Trade.—The word "trade" has so often an evil sound in the ears of those interested in art and craftsmanship, that the announcement that this year's spring exhibition at the Whitechapel Art Gallery was to consist entirely of work from trade schools belonging to, or subsidised by, the London County Council, has probably made many people think that, from the point of view of art, it would be a negligible quantity. But this is very far from being the true state of the case, and the show this year includes very nearly, if not quite, as much art work as it has done in previous years, when the work came from the art and technical schools as a whole. This is probably due, in part, to the fact that in the London schools of art design for manufacturing processes is very often shelved, looked down upon, or practically ignored. It is interesting, as well as encouraging, to see that in the trade schools the teaching of art seems in very many cases to go, of necessity, hand in hand with the proper teaching of a trade. The art will probably flourish all the more healthily from the fact that the student looks upon it as part of the necessary working equipment for his trade, and has not much temptation to consider his immature efforts at design or adaptation in the light of artistic achievements. Perhaps if, in the past, the young designer for manufacturing processes had been encouraged at school to take up

something more like this attitude towards his work, we should now have, not only more competent general designers working on their own account, but also more artistically trained trade designers and fewer unemployed—it would hardly be kind to say unemployable—art students.

Art Work in the London Trade Schools.—At Whitechapel there is, perhaps, rather a larger show of artistic work from the girls' trade schools than from the boys'. One wonders whether this may mean that there are fewer boys than girls taking advantage of the day technical schools. If that were the case it would not be surprising, as it appears that, while the course in the girls' schools is supposed to fit the students to go out as, at least, improvers, that in the boys' schools is, as a rule, only intended to lead up to apprenticeship. (Book production and wood-carving are, however, exceptions to this rule, and there may be some others.) This being the case, it must sometimes be difficult to convince parents that it is wise to let their boys begin their apprenticeship when they are between sixteen and eighteen years of age, even when they can afford to take such a course. If we turn to the artistic exhibits from the boys' schools we find that they consist of woodwork, metalwork, and the arts and crafts connected with book production. The largest exhibit comes from the Shoreditch Technical School, and shows a very high level of accomplishment. The boys in the woodwork class are evidently taught the intelligent and tasteful use of simple marquetry patterns, and shown how to make the best artistic use of the grain of the various woods. Among the exhibits are a large, very well-proportioned bookcase (it is a pity that the student did not choose a rather more elegant shape for his patch of colour in the lower doors), a pretty little satinwood table with a dainty design in inlaid veneers round the edge, and some good simple chairs. The metalwork, mainly fire-irons, hinges, and the like, is very vigorous, and shows good appreciation by the students of the quality of the materials with which they are dealing. There are some workmanlike drawings, too; but the ideal of design shown by the sheet of drawings adapted from the horse-chestnut is not very laudable. The articulation of the stem is, of course, an important point for the designer to note and to use, but it must be observed and used intelligently, and not in a purely mechanical fashion. The School of Art Wood-carving, at South Kensington, sends a couple of boards, to which are affixed a fair number of specimens of the work done by the day scholars. The exhibits, which include one panel to which a prize was awarded at the National Competition, show not only a creditable amount of artistic appreciation, but also a high standard of technical skill. There is a case of silversmiths' work, including one or two very pretty little bits of *repoussé* work, from the Central School, and another case of work connected with book production. Many of the exhibits in this division are very creditable and show a good sense of proportion and spacing, though some of the tooled lettering might with advantage have been omitted from the collection.

The artistic work of the girls' schools resolves itself almost entirely into needlework of one sort and another, and consists mainly of embroidery and braiding of various kinds, done in connection with upholstery, tailoring and dressmaking. The best artistic work in upholstery comes from Shoreditch, where the girls seem to be taught to make their work tell to the best possible advantage, and to have some idea of what is pleasing in colour. The brown cushions, modestly braided with a variegated braid, are admirable of their kind, and there is a cloth curtain, ornamented with a simple pattern—partly cut out with a background of silk showing through—which is very tasteful. The largest, and perhaps the most attractive show of embroidery comes from Woolwich, and includes, besides a very pretty collection of samplers, some interesting *appliqué* work and stitchery on soft leather, admirably adapted to the trimming of coats and skirts. The samplers are beautifully neat, and some of the stitchery on the dresses, etc., is very good, but the students sometimes go very wrong in their colour-schemes. They appear frequently to be aiming at something which would be quite good if it came off, but it so often seems to fail. The workmanship, also, is too exclusively of one type; it is a very dainty type, it is true, but it does not seem by any means to cover all the kinds of embroidery which would be useful to dressmakers and tailoresses. It is the kind of stitchery almost universally in favour in the Council's schools at the present moment, but it covers a comparatively small portion of the field of artistic needlework. The embroidery from the Borough Polytechnic makes a less striking show, but it appears to indicate a fairly comprehensive course of study, and one which should enable students to adapt themselves readily to different kinds of work. Some of the *appliqué* work for upholstery cannot be said to be satisfactory, artistically speaking, and the colour-schemes generally are rather dingy, but the samplers and other work executed in connection with the dressmaking and tailoring classes show a good range of stitches and methods, and an appreciation of how to use braiding and *appliqué* judiciously and with effect.

EMPIRE NOTES.

The Nigerian Tin Fields.—A book entitled "Nigeria and its Tin Fields" has just been published. It is an exceedingly interesting volume by Mr. Albert F. Calvert, and gives a glowing account of the mineral wealth of Northern Nigeria. Tin is not really a common metal, and is in growing demand for a variety of industrial purposes. The existing fields from which supplies are drawn are very limited. The county of Cornwall, the Dutch East Indies, Tasmania, the Malay Peninsula, and the Straits Settlements are responsible for most of

the world's supply. The author asserts that the province of Bauchi is enormously rich in alluvial tin deposits. The deposits cover so wide an area that they are likely to yield large quantities of metal for many years to come. At the present time the price of tin is approaching £200 per ton, which shows that the supply is quite unequal to the demand. If, therefore, these tin-fields be all that is claimed for them they will prove a welcome boon to British manufacturers.

Rhodesian Prospects.—The report of the British South Africa Company for the year ending March 31st, 1910, is just to hand, and shows in detail the rapid progress being made in Rhodesia. This year is the most successful in the history of the company. The report states that substantial progress is being made, especially in the farming industry of Southern Rhodesia. A number of changes in the methods of inducing settlement have taken place, and concentrated efforts are being made to take advantage of the good prospects which the country offers for farmers and stock breeders. The local markets are being widely extended. This is due in a large measure to the continued growth of the mining industry. Many new districts have been opened up in Southern Rhodesia, and there has been an increase in the number of country townships. General business appears to be broadening, and the population of the principal towns is outgrowing the available accommodation. The building trades are flourishing. It is proposed to concentrate land settlement during the coming year in the districts of Lomagundi, Hartley, and Mangwendi in Mashonaland; and Gwelo (including Charter), Belingwe, Wankie, and possibly Mafungabusi in Matabeleland. An encouraging feature of the year has been the increased number of applications received for land suitable for ranching. Considerable areas have also been acquired by experienced stock farmers possessed of ample capital for their development, and the selection of land by the Lemco and Oxo companies has practically been completed. The tobacco industry continues to expand. During the season 1909 to 1910 the area under cultivation was estimated to be 700 acres. This area will be largely increased during the present season, provided that a sufficiency of native labour is forthcoming. The high quality of the leaf is maintained, and the last season's crop would have shown a considerable improvement over the previous year but for an untimely drought in February, followed by heavy rains, which resulted in there being a second crop bearing a coarser and rougher leaf. The prospects for the ensuing year are excellent, the planting season being one of the best on record. It is understood that the question of manufacturing tobacco is now under consideration, and there is every reason to believe that a successful undertaking awaits development.

New Departures in Shipping.—There appears to be no limit to the progress of the British mercantile marine, as each succeeding year shows an appreciable advance on the previous year's operations. The passenger traffic between the United Kingdom and Australia has increased considerably during the past ten months, and at present it is with difficulty that the requirements of third-class passengers are met. There is urgent need for a new service between London and the southern continent. The shipping companies are doing their utmost to cope with the traffic, and to this end the P. & O. Branch Service (formerly Lund's Blue Anchor Line) have converted the accommodation on all their vessels into third-class cabins, thus carrying one class only. This is a great advantage to third-class passengers, as thereby they have the run of the entire ship and are not restricted to the steerage quarter. The Liverpool White Star Company inaugurated this arrangement many years ago and it proved a great success. Messrs. Geo. Thompson & Co., of the Aberdeen line, have just despatched to Australia the latest addition to their fleet, the T.S.S. "Themistocles." She is a splendid twin-screw steamer of 11,400 tons register, and has accommodation for first and third-class passengers. A novelty in cabin structure is introduced in this steamer, one deck being entirely devoted to single-berth cabins, which can be made inter-communicable if desired. A full cargo for homeward voyages is readily obtainable at the Australian ports. The Imperial Steamship Company has received its charter from the Canadian Government, and it proposes to give effect to an "all-red" line between this country and the Antipodes. A service will be established by means of "ferries" from England and Scotland to Ireland, thence *via* Blacksod Bay to Halifax, and from Vancouver to Australia and New Zealand. The vessels are to be able to cross the Atlantic in three and a half days, and a speed of twenty-five knots an hour will be run on the Pacific.

Canada's Emigration Restrictions.—Mr. W. D. Scott, Superintendent of Immigration for Canada, giving evidence before the Dominion House of Commons on Colonisation and Agriculture, pointed out that the immigration restrictive regulations had resulted in a greater influx of people and a marked improvement in the class of settler. He stated that two hundred officials employed on the international boundary, during 1910, refused entry to 14,131 settlers from the United States who were considered by them to be undesirable. Only 252 British settlers had been refused entry during the same period. Compared with the large number of persons who emigrated from the British Isles to the Dominion last year, and having regard to the restrictive measures in force, these figures are remarkable.

Tariff Revenue in Australia.—In a leading article, the *Melbourne Age* expresses extreme dissatisfaction at the increase in revenue from the customs duties. It says: "The duties on goods

which ought to be made in Australia, and yet owing to deficient protection are still imported, continue to increase at a remarkable rate." A number of instances are cited, the most important being apparel and all kinds of soft goods, which, during the ten months, January to October, 1909, were imported into the Commonwealth, to the value of £10,482,793, and in 1910 to the value of £12,353,874. Other manufactured articles which show a big increase in imports are boots and shoes —1909, £222,210, and in 1910, £304,818. The newspaper considers that the tariff should be amended in an upward direction in order to ensure many of the articles named being manufactured in Australia.

Ex-Service Men and Emigration.—A meeting was held early last month at the Royal United Service Institution, Whitehall, having for its object the consideration of the question of ex-service men and the openings for them in our over-sea dominions. The chairman, Field-Marshal Lord Roberts, referred to the need of many of these men who had served their country at home and abroad and who, on re-entering civil life, found it difficult if not impossible to secure regular employment. For such men he thought something should be done to enable them to obtain work overseas within the Empire. He did not advocate emigration for the men who could find suitable employment at home, but, knowing as he did many cases of want and distress on the part of men well fitted for colonial life, he strongly favoured the work which had been begun by the Naval and Military Emigration League, under whose auspices the meeting was held. Some interesting information was given in regard to the work of this league by various speakers at the meeting, one of whom, the Rev. H. C. Martin, the secretary of the Royal Army Temperance Association, Simla, spoke of the opportunities which such an organisation would have in India, in the interests of soldiers who were leaving the Service and who desired to settle in Australia, Canada, or South Africa. Other speakers, among whom were Field-Marshal Lord Grenfell and Mr. Walter Hazell, chairman of the Emigration Committee of the Central Unemployed Body, spoke of the necessity of making some adequate provision for men on leaving the colours, as well as for those who, having left, could not find their niche in this country, but for whom opportunities of profitable employment could be found in the colonies. It was stated also that it would materially aid the work of enlistment, if it were known that openings could be found for soldiers, when their term of service ended, in other parts of the Empire.

OBITUARY.

The Hon. George Payne, J.P.—Intimation has been received of the death from pneumonia of Mr. George Payne, of Durban, while on a visit to this country in October last. Mr. Payne, who was in his sixty-seventh year, had lived in South Africa for nearly half a century. He started in business in Maritzburg, but in 1870 he entered into partnership with his brother in Durban, where they became one of the largest firms of wholesale and retail outfitters in the Colony. Mr. Payne took a deep interest in municipal and political work. He was thrice mayor of Durban, and for a short period Treasurer of the Colony of Natal. He joined the Royal Society of Arts in 1902.

GENERAL NOTE.

Insect and Fungus Pests.—According to Dr. R. Stewart MacDougall, of Edinburgh University, the harm done by insects and fungi, and the toll levied by them on various crops, can scarcely be exaggerated. A fungus wiped out coffee plantations in Ceylon. The Nun moth several years ago cost the Government of Bavaria, in destruction of spruce forest, £100,000. The money loss on account of insects and fungi in the United States represents in a year a sum of money greater than the cost of the year's upkeep of the American Army and Navy, and over a ten years' period the amount of timber killed and reduced in value in America by insects represents an average loss of 62,500,000 dollars a year. Fungi are plants which, in addition to having no distinct root, stem and leaf, but really just a mass of branching threads for their vegetative structure, contain no chlorophyll. By virtue of the possession of chlorophyll (the green colouring matter of the plant) other plants are capable of leading an independent existence. No fungus is independent. In order to live, therefore, a fungus must strike up a partnership with an independent plant, as is the case with lichens, or must prey on live animals, as with the ringworm fungus, or must prey on live plants, as the fungus causing larch disease, or must live saprophytically on breaking-down organic matter, like the mushroom and some moulds and rots. Both insects and fungi pass through a definite life-cycle, and, as aids in the solution of their life-struggle, have various ways of tiding themselves over untoward conditions, and of spreading themselves when the conditions are favourable. A knowledge of the different life histories is necessary before treatment against their attacks can be rational and successful.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

March 22.—Arthur Charles Davis, F.C.S., Assoc.Inst.C.E., "The Manufacture of Portland Cement."

March 29.—George B. Heming, "Art Education in Jewellery and Goldsmithing and Allied Trades." Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., will preside.

APRIL 5.—HENRY L. HEATHCOTE, B.Sc., "Wheels, Ancient and Modern, and their Manufacture."

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

APRIL 27.—SIR THOMAS HENRY HOLLAND, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India." Lord AVEBURY, D.C.L., LL.D., F.R.S., will preside.

MAY 25.—W. R. H. MERK, I.C.S., C.S.I., LL.D., "The N.W.F. Province of India."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

APRIL 4.—Captain R. MUIRHEAD COLLINS, C.M.G., "Australia and her Resources."

MAY 9.—F. WILLIAMS TAYLOR, "Canada and Canadian Banking."

CANTOR LECTURES.

Monday Evenings, at 8 o'clock:—

Professor J. A. FLEMING, M.A., D.Sc., F.R.S., "Applications of Electric Heating." Four Lectures.

Syllabus.

LECTURE III.—MARCH 20.—"The Technical Applications of Electric Heating." The Manufacture of Graphite, Carborundum, Calcium Carbide, Quartz Glass, Aluminium, Ferro-Alloys, and Iron and Steel in Electric Furnaces—Electric Welding—Electric Furnaces for Metallurgical and Chemical Operations.

LECTURE IV.—MARCH 27.—"The Domestic Applications of Electric Heating." Electric Water Heating—Its Cost and Economy—Air Heating by Electric Radiators and Convectors—Electric Cooking—Various Systems and Types of Utensil critically discussed—The Advantages and Drawbacks in Comparison with other Methods of Culinary Heating.

ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

May 1, 8, 15, 22.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 20...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor J. A. Fleming, "Applications of Electric Heating." (Lecture III.)

Bibliographical, 20, Hanover-square, W., 5 p.m. Mr. H. Thomas, "The Bibliography of Amadis of Gaul."

Victoria Institute, 1, Adelphi-terrace House, W.C., 4.30 p.m. Dr. T. G. Pinches, "Professor Hilprecht's newly-discovered Deluge Fragment."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. A. M. Brice, "The Legal Duty of the Architect."

TUESDAY, MARCH 21...Statistical, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. Charles V. Sale, "Some Statistics of Japan."

Sociological, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8.15 p.m. Annual General Meeting. Professor L. T. Hobhouse, "Eugenics and Sociology."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. M. A. Stein, "Explorations of Ancient Desert Sites in Central Asia." (Lecture I.)

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. F. W. Hill, "Open Air Statues in London."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. Philip Dawson's paper, "The Electrification of a portion of the Suburban System of the London, Brighton and South Coast Railway."

Zoological, Regent's-park, N.W., 8.30 p.m. 1. Mrs. E. W. Sexton, "On the Amphipod Genus *Leptocheirus*." 2. Messrs. J. Lewis Bonhote and F. W. Smalley, "On Colour and Colour-pattern Inheritance in Pigeons." 3. Dr. G. Stewardson Brady, "Notes on Marine Ostracoda from Madeira."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mr. T. J. Alldridge, "Sierra Leone and its Commercial Expansion."

WEDNESDAY, MARCH 22...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. A. C. Davis, "The Manufacture of Portland Cement."

Geological, Burlington House, W., 8 p.m.

United Service Institution, Whitehall, S.W., 3 p.m. Dr. T. Miller Maguire, "Improvised Armies in the XIXth Century: an Historical Analysis."

Royal Society of Literature, 20, Hanover-square, W., 5 p.m. Prince V. Bariatinsky, "The Misfortune of being too Clever." A Classical Russian Comedy by Alexander Griboyedoff.

Mining and Metallurgy, at the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m.

College of Preceptors, Bloomsbury-square, W.C., 7.30 p.m. Discussion on "Vocational Education; or, The School as a Direct Preparation for the Work of Life," to be opened by Mr. Cloudesley Brereton.

THURSDAY, MARCH 23...Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Child Study, 90, Buckingham Palace-road, S.W., 6.30 p.m. Annual General Meeting. 7.30 p.m. Mr. W. H. Stuart Garnett, "The Educational Possibilities of the Boy Scout Movement."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. Keith, "Giants and Pygmies." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. R. Humfrey, "Present Day Press Photography, with a Few Experiences."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Messrs. H. A. Ratcliff and A. E. Moore, "Electricity Meters with Notes on Meter Testing."

FRIDAY, MARCH 24...Royal Institution, Albemarle-street, W., 9 p.m. Sir David Gill, "The Sidereal Universe."

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7.30 p.m.

National Health Society, in the Theatre, Burlington-gardens, W., 5 p.m. (Lady Priestley Memorial Lecture.) Mr Stephen Paget, "Pasteur and his Work."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. James Swinburne, "The Uses of Chemistry in Engineering."

SATURDAY, MARCH 25...Municipal and County Engineers (Western District Meeting), Torquay, 11 a.m. Mr. H. A. Garrett, "Municipal Engineering Works, Torquay, carried on during the past seventeen years, viz.:—the Promenade Pier, Sewerage and Floods Prevention works, the Dolter Surface Contact System of Tramways (now being converted to the overhead system), the Refuse Destructor, Municipal Buildings and Pavilion."

Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Radiant Energy and Matter." (Lecture IV.)

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FRIDAY, MARCH 24, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 27th, 8 p.m. (Cantor Lecture.) Professor J. A. FLEMING, M.A., D.Sc., F.R.S., "Applications of Electric Heating." (Lecture IV.)

WEDNESDAY, MARCH 29th, 8 p.m. (Ordinary Meeting.) GEORGE B. HEMING, "Art Education in the Jewelry, Goldsmithing and Allied Trades." Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., M.D., LL.D., will preside.

CANTOR LECTURE.

On Monday Evening, March 20th, Professor J. A. FLEMING, M.A., D.Sc., F.R.S., delivered the third lecture of his course on "Applications of Electric Heating."

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A Meeting of the Indian Section was held on Thursday, March 16th, 1911, the Right Hon. Lord NORTHCOTE, G.C.M.G., G.C.I.E., C.B., presiding.

The CHAIRMAN said it was a particular pleasure to him to have the honour to occupy the chair that afternoon, and to introduce Mr. Hill. For many years—in his capacity as Governor of Bombay—he had had the advantage of the invaluable services of Mr. Hill. To those amongst the audience who were personally acquainted with India, the author of the paper would need little or no introduction. He was a gentleman who had served with distinction in many parts of India, and who had had the good fortune to possess in no common degree the esteem and confidence of many of those ruling chiefs and leading natives of India, without whose confidence and good-will the task of governing India successfully would be infinitely more difficult.

The paper read was—

EDUCATION IN INDIA.

By CLAUDE HAMILTON ARCHER HILL, I.C.S., C.S.I., C.I.E.

I fear that the title of this paper may suggest that it is proposed to enter upon and discuss the whole problem of Indian education in all its aspects. Not only, however, would that be impossible in the space allotted, but I could lay no claim to special qualifications entitling me to attempt such a task. It is to one particular feature of the problem—one in regard to which an intimate and friendly acquaintance with many individual Indians, and with their views and feelings in the matter, is even of greater importance than an abstract knowledge of the educational system—that I venture to invite your attention. I refer to religious or moral training.

In his masterly treatise on "Indian Unrest," Mr. Valentine Chirol devotes no fewer than five chapters to the subject of education, and one of them solely to the question of religious instruction; and that may be taken to be the measure of the importance to India of the problem. It is possible that if, at the time when I was asked to name the subject of my paper, I had had access to the whole of Mr. Chirol's articles, and had realised how fully he had dealt with this matter, I might have refrained from this attempt to give prominence to it; but on reflection it has seemed to me that the political point of view from which, in Mr. Chirol's work, the subject was of necessity regarded, is not the only, or perhaps the most important, one, and that there may be advantage in examining our position in the matter rather from the ethical standpoint.

I propose, first of all, to give you, in the briefest possible outline, a sketch of the history of the connection of the Government of India

with the promotion of education in India, and of the direction in which their policy towards moral instruction was moulded; then to describe the attitude, as I understand it, of the Indian mind towards education and religion, and to lay before you certain considerations which seem to indicate that we should reconsider the rigidity of our policy of secularisation; and, finally, to make one or two suggestions as to the methods by which the change might be effected with the least difficulty and risk.

Up to the year 1813 the little that had been achieved in education in India upon modern lines was due almost entirely to missionary enterprise, and outside the sphere of missionary activity, and away from the larger centres, the instruction of youth was confined, speaking generally, to the teaching, here and there, of reading and writing and of the Hindu scriptures to some of the members of the priestly and clerical castes. Between the years 1823 and 1840, committees of public instruction, under various names, were established in Bengal, Madras and Bombay, and some progress was made by these bodies in establishing English and vernacular schools. Prior to 1839 a lively contest took place between the advocates of Oriental and Western education, which, through the influence of Lord Macaulay, resulted in the adoption of a system based on English principles. But the basis upon which the educational system of India still rests to-day is that outlined in the important despatch of the Court of Directors, dated July 19th, 1854, much of which I should like, if time permitted, to quote here. I must, however, confine myself to such brief extracts as have a direct bearing upon the restricted aspect of education with which this paper attempts to deal. After emphasising in paragraph 7 the decision arrived at by Lord Auckland's Government in 1839, "that the education which we desire to see extended in India is that which has for its object the diffusion of the improved arts, science, philosophy and literature of Europe; in short, of European knowledge," the Court of Directors proceeded to outline the organisation of separate departments of education in each Province, the establishment of universities at the Presidency towns, and of institutions for training teachers; the maintenance and establishment of colleges, high schools, middle schools and elementary schools, and the introduction of a system of grants-in-aid on a basis of perfect religious neutrality. The wording in regard to this last-named point is instructive and important. In paragraph 53 Sir Charles Wood wrote that "The system of grants-in-aid, which we propose to establish in India, will be based on an entire abstinence from interference with *the religious instruction conveyed in the schools assisted.*" At the same time, although, in dealing with the university examinations to be prescribed, it was stated (paragraph 28) that the "examination for degrees will not include any subjects connected with religious belief," and (paragraph 32) that there would be ample field, in connection with the teaching of the Oriental classics, "unconnected with any instruction in the tenets of the Hindu or Mohammedan religion," it is clear that the Court of Directors, when pressing for the establishment of schools all over India under local management, subject to Government inspection, contemplated that religious instruction *would* be imparted, and that such instruction would be no bar to the receipt of a grant-in-aid, provided that the school was otherwise conducted up to the requisite standard of efficiency.

As a matter of fact, the grant-in-aid system proved only a very qualified success owing to the apathy of the people, and a few years later it became necessary to consider the levy of a special rate on land to defray the cost of providing for elementary education.

As a result of the recommendations of the Education Commission of 1882, primary education was given an almost exclusive claim to local funds set apart for education, and the control over the expenditure and the management of the schools was given to local bodies, who, under more recent orders, are stringently required to allot a fair proportion of the cess to education, and the bulk of that sum to primary education. Many important matters were dealt with by the Educational Conference of 1901, and discussed in a comprehensive review of the progress of education, issued by Lord Curzon's Government in March, 1904, of which, for present purposes, the most important portions were those (paragraphs 25, 38, and 40) which affirmed the supreme importance of providing a properly-trained teaching staff, and dealt with certain tendencies unfavourable to discipline which had then come so prominently to notice. In respect of these it was observed that "in Government institutions the instruction is, and must continue to be, exclusively secular. In such cases the remedy for the evil tendencies . . . is to be sought not so much in any formal methods of

teaching conduct by means of moral text-books, or primers of personal ethics, as in the influence of carefully-selected and trained teachers."

The earliest efforts at imparting education to India having been due to missionary enterprise, it was natural that the Government, when they began to realise their responsibilities in the matter, should be especially careful to guard themselves against any suspicion of participating in a proselytising movement. Hence the repeated reassuring declarations of strict neutrality. It is, however, worth while strongly to emphasise the point that the Court of Directors fully contemplated that, in the elementary schools (which they hoped would find local support and only be aided by Government) religious instruction, according to local needs, *would* be arranged for; and that Sir Charles Wood's despatch only laid down that we should not interfere with that branch of education. Elementary education is now supported mainly by the local cess and administered by local bodies under Government supervision and inspection; and, in the strictest interpretation of the policy laid down in 1854, it is possible to hold that there is no bar to those local bodies arranging for regular religious or ethical instruction, unless it be the reiteration, in the orders I have quoted, of 1904, that "in Government institutions the instruction is, and must continue to be, exclusively secular." The village school, in the vast majority of cases, is technically a Government institution; but the local body administering it, at the cost of the local cess, may fairly be regarded as being in the position contemplated by the Court of Directors when laying down the policy of the grant-in-aid.

I may now turn to the attitude of the Indian mind towards this question, with a preliminary explanation in respect of the terms used. Besides Hindus, in countless castes and sects, the Indian peninsula is peopled by Mohammedans, Sikhs, Jains, Parsis, and so forth. But the Sikhs and Jains are racially Hindus, and so is a very large proportion of the Mohammedans, while the others are numerically small. What I shall have to say of the Hindu or Indian mind, therefore, applies, in essentials, to the mentality of many of the religious sects who do not, strictly, come within the category of the Hindus.

As has been well said in Chapter XX. of "Indian Unrest":—"In India . . . religion in some form or another . . . is the dominant force in the life, both of every individual and of every separate community to which the individual belongs. Religion is, in fact, the basic element of Indian life, and morality, apart from religion, is an almost impossible conception for all but an infinitesimal fraction of Western-educated Indians." Mr. Chirol's conclusion that, such being the case, any attempt to instil ethical notions into the mind of the Indian youth, independently of all religious teaching, could only result in failure, will be referred to later. The reason why religion plays such a fundamental part in India is not far to seek. Whether Manu was a Kshatriya who assumed the priestly office, or whether he was a Brahmin, the fact remains that the Code to which his name is attached represents the social ordinances of a people, or rather peoples, of very complex civilisation, devised and carried into effect over a period of many generations, but having, as their ultimate sanction, not the mandate of a temporal sovereign, but the force and rigidity of the divine will. In a community whose social laws were invariably framed by the hereditary priestly caste, it was perhaps natural to claim for them divine inspiration; and the result, which it is so difficult, and yet so important, for us to appreciate, is that the whole social system in India, which has persisted through so many centuries, rests upon a religious basis. That system, moreover, is prescribed in such detail, and has, for each item, such specific religious sanction, that there is no act or event of the ordinary day which has not a religious symbolism. "The fetching of water, the ablution, the preparation and consumption of food, the transaction of business, the setting forth upon a journey, the crossing the threshold of a house, each and every one of these daily functions is associated, more or less consciously, with the observance of some" ritual, or some recognition of or obeisance to the god-head. With the vast majority of the subject peoples plunged in darkest ignorance, the need for impressing upon them the divine nature of the social ordinances helped to give rise to the multiplication of the deities. The loftier conceptions of the higher Hinduism could not be expected to appeal to intelligences untrained. Hence, and partly, perhaps, as a counterblast to the purity of the democratic teachings of Gautama, were evolved the multitudinous, and so often degraded, symbols of the deity adapted to the concrete requirements of everyday life. Marred as much of the beauty of the higher Hinduism has been to suit the popular understanding, the fact remains that

the whole life of a Hindu, from ages before his present birth till countless ages after, is regarded as one eternal, foreordained association with the divine; as a cycle of births each connected with the last. It is thus that Hinduism is a universal pantheism, involving the eternal perpetuation of a social system rooted in the very essence of itself; and it is for the foregoing reasons that the social law, regarded less as a rule of conduct than as an emanation of the divine purpose of the Universe, has been and is so rigid and immutable. Ritual and ceremonial, ill-understood and ignorantly performed, perhaps, by the mass of the people, but yet helping to form a rule of life and conduct, were, therefore, part and parcel of the upbringing of the Hindu child. In cases where the child went to school, the parent assumed, with good reason, that such teaching as he received included, as an essential adjunct, the learning of some portions of the sacred books.

Now, as is well-known, a cardinal feature of the teachings of the Hindu sacred literature is the stress that is laid upon the respect due to a parent by his children, by the student to his *guru*, and by the subject to constituted authority; with the result that in no country in the world was the family tie so strong, or the instinct of deference to age and learning more pronounced. And it was into a community with such traditions of reliance upon authority that we introduced, with the most benevolent intentions, a system of Western education based on Western ideas, but bereft of the one element which entered into all the social relations of the people. The laudable efforts of Government officials resulted, after 1854, in a very great expansion of the school-going population; but, since the hoped-for scheme of grants-in-aid of schools indigenously established proved abortive, or at least met with only very qualified success, the schools newly established were, in the vast majority of cases, Government institutions which made no provision whatever for religious instruction. Parents, acquiescing in accordance with their traditions, permitted their sons to go to the Government schools and asked no questions; while it seems till recently never seriously to have occurred to the authorities that a radical change in the nature of the people would necessarily follow such a vital alteration in the methods of bringing up the youth of the country.

The change has occurred. Those who deplore it most are the older generation of Indian gentlemen. Hindu, Mohammedan and Parsi parents have told me of the deplorable change in the attitude of children to their parents, and have, many of them, urged that the Government should do something in modification of an educational system which they hold to be responsible for the result. Religion, or at all events ethics based upon religion, they now realise, must be an integral part of an Indian's education; and they ask that, if the difficulties in the way of the establishment by Government of denominational teaching are insuperable, facilities shall be given for imparting a moral training based, so far as may be, upon the ethics common to all the higher religions.

The problem confronting the British Government in India can, therefore, be considered under the following headings:—

Firstly.—Are we debarred, either by guarantees or by policy, or on account of the inherent difficulties in the path, from reconsidering the decision that we should countenance no religious teaching of any kind in educational institutions for which we are responsible?

Secondly.—If we are so debarred, is it possible to devise means whereby the lacuna in the upbringing of the youth of India can be partially made good?

In respect of the first question, regarded in the light of an ethical problem, much might be said. It could be contended that a policy of strict neutrality imposes on us the obligation to give equal opportunities and facilities to the religions of all the nationalities and races over which we hold sway; and it must be acknowledged that this is not the case at present. It could be, and has been, argued that, wherever the State intervenes and undertakes the responsibility of educating the peoples under its dominion, it is bound to provide instruction in the moral principles of the religions professed by those peoples; and a good case could be made to show that the banishment of such tuition from Indian schools, as a result of past policy, has been not neutrality but an unintentional failure to realise a moral obligation. Such guarantees as have been given—as, for example, that contained in Queen Victoria's proclamation of 1858—most certainly do not debar us from giving facilities, to those who desire it, for acquiring instruction in their own religions, and I do not think that the policy as outlined in 1854 can be interpreted as an absolute bar, though it may have been, by inadvertence, more stringently interpreted on subsequent occasions.

If, however, the suggestion I made earlier in this paper could be approved, namely, that

local bodies administering the elementary schools in their charge should be regarded as falling within the category of the aided schools contemplated by Sir Charles Wood, in respect of which, you will remember, the Governments in India were only directed to refrain from interference with the religious instruction therein conveyed, then the flank of the difficulty would be turned; and I believe there would remain no insuperable obstacle in the way of a great and much-needed reform. I should like to quote to you the words of a very eminent Brahmin, holding the highest official position in a Native State, and one enjoying universally the greatest respect and esteem. He addressed a letter to the press in India, about three years ago, urging that Government should leave primary and secondary education entirely to the people, for the reason, among others, that in a huge continent like India, the Government cannot inculcate the moral training and impart the religious knowledge so essential to Indian minds. "It is in primary schools," he wrote, "that the foundation of moral ideas is laid, and it is primarily the text-books of these schools which have to infuse in infant minds the ideal of a moral and virtuous life."

It will no doubt be said that, even if there be neither guarantee nor policy which absolutely debars us from modifying the system of education as hitherto applied, there are practical difficulties of an insuperable character in the way of any scheme of religious instruction under the ægis of the State. At a conference on this subject, held in Bombay at the instance of His Excellency Sir George Clarke in April, 1910, several speakers emphasised the difficulty incidental to the number and diversity of the races and religious creeds, even in one province. The difficulties may at once be admitted, but that they are not insuperable requires little demonstration. It is, of course, well known that the State of Mysore has incorporated in its curriculum a scheme of religious and moral training; but it is, perhaps, not equally widely known that a considerable number of aided schools and private institutions in British India and in Native State territories, have also adopted the text-books of the *Sanatan Dharma* series (published by the Hindu Central College at Benares), and have regular courses of instruction in them. Now there are Mohammedan pupils in the Mysore State, and non-Hindu pupils in the other institutions; but I have not heard of a single instance in which difficulty has arisen, or objection has been taken, on that account. And yet, that there is, *primâ facie*, room for such objection is manifest to anyone who will study the books of this series. While in themselves innocent enough, they are so essentially and exclusively Hindu and so peculiarly transcendental in their teaching, that they are open to criticism, not only at the hands of pupils professing other faiths, but on the ground that in the higher series they are less concerned in inculcating a high ethical standard of conduct than in instilling the principles of a philosophy peculiar to a certain and limited class of Brahminism. And yet these text-books have achieved a certain vogue, and their use is extending, while shorter adaptations of their doctrine are being prepared for local use by some more intelligent headmasters. I have laid, perhaps, undue stress upon these Benares publications, because they, and their adoption in a considerable number of schools, are an indication, first, of the possibility of giving religious instruction in India, and, secondly, of the awakening of the people of India—especially the older generation—to the absolute necessity of devising means for affording definite and systematic training for their children in the ethics of their religion.

Thus far it has been suggested, on a consideration of the history pertaining to our control of Indian education, that it has not been our deliberate policy to oust religious instruction from the schools of India, but that the practice has been the result of an excessive scruple, coupled with the apathy of the people themselves, who failed adequately to support and foster elementary education. The published views of an eminent Indian (Brahmin) authority have been cited in support of the policy of Sir Charles Wood in respect of leaving primary education to the people themselves, with full liberty to provide, under proper inspection, for the religious and moral training of the pupils. An endeavour has also been made to bring out clearly, not only the essential importance of their religion to the Indian peoples, but also to show that the older generation now fully realises the lamentable result of neglecting it. It remains to offer some suggestions as to methods for introducing the change which seems so urgently called for. And, as a preliminary to the discussion of this part of my subject, I must refer again to the communication, already twice-quoted, from my Brahmin friend, in which he argued in favour of handing over elementary education to the people. The underlying reason was a sound

one, being based, in fact, on the principle of decentralisation. In the continent of India it is impossible to aim at uniformity; and, therefore, in the remarks which follow, it is assumed, as an unalterable principle, that, if success is to be achieved, the greatest elasticity must be allowed.

The attention of many of you must have been drawn to a series of most interesting letters which appeared in the *Times* on the subject of Education in India, from the pen of the Rev. Dr. Miller, lately Principal of the Madras Christian College. Adopting a line of argument very similar to that which I have followed in my endeavour to show that the true policy laid down in 1854 has been misunderstood and misapplied, Dr. Miller advocates greater encouragement and a more liberal financial support to those private institutions which unquestionably come within the scope of aided institutions as contemplated by Sir Charles Wood. He writes:—"If the broad principles laid down in 1854 were henceforward to be fully acted on, if liberal aid and sympathetic superintendence began to be afforded to private effort, there cannot be a doubt that schools and colleges hereafter to be founded by Hindus and Mohammedans would be based on the tenets of their faiths, and would exert an influence on the students in attendance enormously more healthy than that of the secular schools and colleges." It will be realised, from what has gone before, that I most cordially endorse this view, but that what is advocated in this paper goes very much further. I am not so familiar as Dr. Miller is, of course, with the conditions ruling in Madras, but in other parts of India, in the case of elementary schools, the proportion of institutions owing their existence to private enterprise is almost a negligible quantity, and, unless the principle is expanded so as to cover those institutions, quasi-Government schools though they be, which are supported by local funds and administered, under Government supervision, by local bodies, it is to be feared that many generations would pass away before an appreciable improvement took place. The village schools, as well as the elementary schools in the towns, are those which it is so pre-eminently desirable to reach; and though a percentage of such schools in the towns are private institutions, practically all those in the mofussil are departmentally controlled. If the view that "it is in primary schools that the foundation of moral ideas is laid"—fortified as it is, I believe, by the experience in other countries—be accepted, then, if the policy here advocated is to be effective, it must be applied more widely than is demanded by Dr. Miller.

It is, however, of no advantage to blink difficulties, and a very real one occurs here. It will not suffice, in the case of those schools, whether private or administered by local bodies, for Government merely to inspect and approve the secular curriculum, leaving the religious or moral course of training severely alone. In the case of more than one private school (*not* in Bengal) it is within my personal knowledge that the liberty to teach religion, unfettered by any check, has been grossly abused; and that the true doctrines of the Hindu sacred books have been hideously perverted to serve political ends. Such a state of things is, of course, exceptional; moreover, no degree of control could be made effective for its complete suppression. Nevertheless, it is a fact to be reckoned with, and one which makes it dangerous to subscribe to Dr. Miller's conclusion that the State should not only "abstain from interference with the religious instruction forming part of the course in the institutions which it aids, but" should "take no notice of whether religion is included in their course or not, provided they are certified to be in other respects efficient." This is an echo of paragraph 56 of the Despatch of 1854, where, dealing with the duties of educational inspectors, it was directed that "*no notice whatsoever* should be taken by them of the religious doctrines which may be taught in any school," which, if strictly carried into effect, would debar an inspector from reporting on the existence of abuses such as have been referred to. These abuses could not have been foreseen fifty years ago; and the difficulty, in adapting the general lines of the policy then laid down to the exigencies of today, lies in steering the middle course between active interference and the *laissez-faire* for which Government are so much blamed by Indian parents at the present time. It must be remembered that India is not, as England is, a country in which local authorities have always administered their own affairs and are quite capable of safeguarding their own interests. It is not only possible, but it not infrequently happens, that in India a local school, or other institution, is conducted upon lines which are cordially disapproved of by a majority of the inhabitants. Partly because of an innate apathy, more, however, on account of the tendency of the people to lean on Government, or its local representative, in all things demanding action

or initiative, a most undesirable state of affairs might continue indefinitely, without any rumour of it reaching the ears of authority, in respect of *any* matter of which the Government publicly notified a policy of rigorous non-inspection. We should, therefore, I submit, be evading our responsibilities if we went the lengths suggested by Dr. Miller. But a middle course is not altogether incompatible with the prescribed policy. Inspection is not interference. Supervision is not direction. The aim should be, by regulated instructions, to cause our educational inspecting officers, while abstaining from interference, to satisfy themselves that the religious instruction conveyed is of an appropriate, or at least harmless, character; and the regulations could be so framed as to secure that no initiative, in dubious cases, should be taken without the sanction of the local Government.

The difficulty which is always put in the forefront of those resisting the reform has now to be faced. It is stated continually, as though the statement carried its own demonstration, that the diversity of races, languages and religions, which find their place in India, is so great, and that the various religious denominations are so closely intermingled, that it would be impracticable to prepare text-books to suit all requirements or to devise means for imparting instruction in the many doctrines whose followers would be found even in the same school. It has already been frankly admitted that the difficulty exists; but there has as yet been no organised attempt to find a way out of it. It has been shown, by a reference to the adoption of the *Sanatan Dharma* text-books in so many schools, that the difficulty has been enormously exaggerated. It has also been suggested that, if the obstacles are to be overcome, the cardinal principle to be borne in mind is "Decentralisation." If the idea persists that there should be uniformity of text-book, and similarity of method, even for the same denominations, throughout the continent of India, then failure is assured. But, once it is realised that each locality will, if permitted, speedily devise its own methods, and, with the benevolent assistance, but without the direct interference, of Government officers, elaborate its own text-books, the greater part of the difficulties will vanish at once. Let me take the Bombay Presidency, with which I am, on the whole, best acquainted, as an example; and let me exclude Sindh, which is a province apart. Three, or, if Urdu be included, four main languages are spoken. The population includes Hindus of both denominations (Vaishnavas and Shaivas); Mohammedans, both Sunnis and Shias, orthodox and unorthodox; Parsis; Hindus of the Jain persuasion; Lingayets, and so forth. Let us suppose that the Secretary of State and the Government of India have issued orders permitting the introduction of religious instruction in the schools of such of the local authorities as may ask for it. The Bombay Government would doubtless convene meetings of small committees of representative men, from the distinctive localities, of such branches of the community as were affected by the demands of local authorities; and these committees, in consultation, if necessary, with the educational department, and with its assistance if asked for, would very quickly determine upon the kind of religious instruction they desired, and upon the person or persons best fitted for drawing up such text-books as might be considered necessary. And the Educational Department would render such assistance in the matter of preparation and printing as might seem justifiable and appropriate.

One objection still remains untouched. A large proportion of Indian village schools includes Mohammedans as well as various denominations of Hindus on their rolls; and it may quite easily happen that, while instruction in the moral principles of Hinduism could be arranged for in a given locality, it would be difficult or impossible to provide for the religious instruction of the Musulmans. This, I suggest, is an obstacle in the way of the complete introduction of this reform, but in no way vitiates the argument for its partial institution. Both Hindus and Mohammedans, in India, are, as a rule, extraordinarily tolerant; and it is conceivable that, rather than attend no class of religious instruction, the Mohammedans, in the case I have supposed, would attend the Hindu lesson. Thus, provided, so far as Government and the local authority are concerned, attendance for this particular subject remains optional, or compulsory on individual boys only at the express wish of the parents, the objection would not be a practical one.

It is, however, less the aim of this paper to suggest devices for overcoming the difficulties in the path of what is so universally regarded as a most necessary change in our scheme of education, than to put forward reasons why a practical endeavour should be made to assess those difficulties authoritatively—in other words, to urge that the time has now come for seriously

grappling with the problem. The moment is opportune. The first Minister for Education—a Minister who bears a name which, of itself, carries weight in the educational world—has just been appointed. He will find the ground prepared everywhere for reform. Should there still be reason for hesitation as to whether the community is ripe for the change, let a commission, or provincial commissions, composed largely of the real leaders of the Hindu and other communities, be appointed to inquire, deliberate and report; and let the subsequent line of action depend, so far as is possible with due regard to the preservation of general principles of policy, upon local conditions and demands.

There remains for consideration the question whether, if the obstacles in the way of permitting the teaching of morals upon a religious basis in Indian schools are ascertained to be insuperable, there is no alternative method. Even if this question did not thus arise in a practical shape I should be ignoring a most important factor in the discussion were no reference made to the work, in regard to India, which is being done by the Moral Education League. However strongly one may share the views of the great majority of those who, familiar with India, and with Indians in India, believe that, to be efficient in the best and highest sense, moral instruction must there, more than anywhere else, be taught in conjunction with, and upon the basis of, the religions of the different peoples, it has to be recognised that a change of policy of the magnitude involved in a subversion of the practice of more than half a century is not lightly to be entered upon; and that a false step, taken in haste, would be conceivably worse than none. There are many of those well qualified to form an opinion—and among the number some (a minority) of my Hindu friends—who apprehend difficulty, and perhaps some dangers, in dogmatic religious teaching, chief among those dangers being the inadequacy to the task of the subordinate educational staff in India. To such persons it seems at present preferable that a commencement in the reform movement should be made upon *quasi*-secular lines. In France, in parts of England, and pre-eminently in Japan, there is a tendency for moral training divorced from religion to take the place of denominational teaching; and the results, so far as can be judged, appear to be satisfactory. Although, to persons who have studied India, it will seem dangerous to draw any close analogy from the practical and progressive nations I have mentioned, and to conclude that the same results would ensue in the case of India, it is nevertheless desirable to take the alternative into consideration. At the moment, indeed, it is essential to do so. Under the auspices of the Moral Education League, Mr. F. J. Gould, with whose work in England you are probably familiar, has drawn up a book of moral lessons for Indian school children which will shortly be published by Longmans, with the title "Youth's Noble Path"; and a prominent member of the League has proceeded to India with a view to organising its dissemination and use in India. The work is admittedly tentative. In a characteristically modest preface Mr. Gould, after explaining that his chapters are to be regarded "as suggestions and types, and not as a fixed code to be rigidly followed," and after laying stress upon the dependence of success upon the teaching staff, concludes:—"I am yet profoundly conscious of the tentative character of the work, and of the immense field that still awaits the careful study of the moral instructor of Indian childhood and youth. Educationists will improve upon my imperfect achievement."

Should it, unfortunately, prove too difficult to adopt a policy which will enable local bodies throughout India to introduce the teaching of ethics upon a religious basis in the schools within their charge, there is thus, ready to hand, an alternative. Mr. Gould's book draws its inspiration from all sources, and bases its teaching upon that of all the great religions impartially. So far as I can judge, there is really nothing in it to which Hindu or Mohammedan, Parsi or Buddhist could take serious exception. Not the most fanatical political opponent of all things British could pretend that its teachings are aimed at making loyal subjects rather than worthy and high-minded citizens. And in such circumstances, should the wider policy be impossible of adoption, we shall have travelled some way in the right direction if we introduce, throughout the Government schools, the practice of systematic moral training upon a secular basis, commencing upon the model now furnished. The Government of Bombay, who in this matter are taking the lead, have already officially determined upon the preparation of a similar text-book, and I understand that the work will shortly be taken in hand. I suggest that, although the greatest weight must attach to Mr. Chirol's view that an attempt of this kind, to instil ethical notions into the

Indian mind independently of religious dogma, is bound to end in failure, nevertheless if we are debarred, in respect of a portion of our schools, from instituting a regular course of religious instruction, we should make the attempt. There is a definite demand for it; and though it may be regarded as a *pis aller*, there will be no hesitation, on the part of the majority of thoughtful Indians, in accepting it as better than nothing.

In conclusion, I desire to anticipate one reply which will be made to the suggestions here thrown out. In the review of educational progress in India issued in March, 1904, to which reference has already once been made, after the observation that instruction in Government institutions is, and must continue to be, exclusively secular, the Government of India observed that the remedy for the tendencies unfavourable to discipline, which had been noticed of recent years, lay "not so much in any formal methods of teaching conduct by means of moral text-books or primers of personal ethics, as in the influence of carefully-selected and trained teachers." With the soundness of this observation everyone must agree; but I would ask anyone acquainted with India, and especially with the conditions obtaining in the subordinate educational service of most provinces, how long we should have to wait for a remedy dependent upon an improvement in the quality of teachers up to the ideal standard contemplated. The Governments in India are doing what they can, with the resources at their disposal, to raise the pay of, and render more attractive, the lower posts in the Educational Department, in order to enlist teachers of better qualifications. In the first place, however, it is to be borne in mind that, owing to the past policy, we cannot at present hope to get material which itself has had any training in moral principles; and, secondly, years must elapse before the lower grades of this service can be so improved as to attract men of the quality stipulated for in the memorandum. The question which suggests itself to those hoping for practical amelioration within a measurable period of time, is whether it is not better to put a good text-book, on whatever subject, into the hands of teachers of questionable attainments, and require them to teach their pupils what is therein written, rather than to leave matters to drift. Moral instruction requires to be systematically conveyed, just as instruction must be systematically conveyed in any other subject. We provide the teachers with text-books on all the others—surely, therefore, we may with advantage put into their hands a book of guidance in ethics. It is neither the easiest nor the least important subject to teach; and even if we could expect workmen who have never learnt how to make bricks at once to undertake the task, we should at least feel bound to furnish them with the necessary materials.

The conclusions which this paper wishes to suggest may be summed up as follows:—

1. The policy laid down in 1854 imposes no absolute bar to the introduction of moral instruction based on religion in aided schools; and it is permissible to hold that the schools supported primarily by local bodies, and administered by them, come within that category.

2. It is in primary schools that it is peculiarly desirable that the elements of moral notions should be taught; and the vast majority of primary schools would come within the scope of the suggested reform.

3. The practical difficulties in the way of introducing the change should, if necessary, be inquired into by a Commission appointed for the purpose; but these difficulties will be greatly diminished if it is once decided that uniformity of procedure and method throughout India is unnecessary and undesirable.

4. The demand for some measure which will make good the deficiency in the educational system is so urgent that, if the difficulties confronting Government are found to be insuperable as regards the introduction of moral instruction upon a religious basis, a scheme of secular moral instruction, modelled for the present upon the work of the Moral Education League, should be given a trial throughout all schools with which Government are concerned.

DISCUSSION.

The CHAIRMAN (Lord Northcote) was sure all present would feel that Mr. Hill had dealt with the great question of Indian education in as comprehensive a way as it was possible to deal with so vast a subject within the limits of time to which the paper had to be confined. Mr. Hill had touched upon some of the notorious weaknesses and defects of the present system of education in a manner which entitled him to the Society's cordial thanks. He (the Chairman) would refer particularly to one of the concluding points of the paper, which urged that text-books, such as were indicated, might with great advantage be furnished to the teachers in rural schools in India. All knew that under existing circumstances the pay and position of the

teachers in the smaller schools in India were so extremely low that it was impossible to get the best men to undertake the work. He thought it was, therefore, essential that there should be furnished to those men, who for some time to come must continue to educate native children, every help which could be given them by a good text-book, in order that they might be enabled to inculcate moral lessons. He also thought there was much to be said for the suggestion that a Commission should be appointed to inquire into the general subject of Indian education, which Commission should report to the Government in what way any schemes for its improvement might be carried out. He need hardly say that he should attach special importance to the report of such a Commission if it were very largely, or, indeed, mainly, constituted of native Indians, who would be better able to judge of the requirements of their fellow-subjects than Europeans.

Sir Theodore Morison, K.C.I.E., said, while he was in substantial agreement with the paper, there were one or two points as to which he did not agree with Mr. Hill. In the first place, in regard to both the paper and also to Mr. Chirol's book, he thought there was a danger of losing the perspective, because of the troubles directly connected with English education which were at the present moment in everybody's mind. People were rather apt to overlook the very great and beneficent revolution which English education had achieved in India. It was but a very short time ago when the morality of Indian public servants was more than open to question, but at the present time the universal evidence of all English officers was that those Indians who had received an English education were absolutely trustworthy. There was a Chief Justice in the province in which he (Sir Theodore) served, who used to say: "If you will tell me those men in the judicial service who have received an English education, I will tell you the honest and incorruptible judges." In a great many other spheres of native life the same remark applied. It was the universal testimony of Indians themselves that the mere acquisition of English education had wrought an extraordinary change in the morality of the people. In asking many Indian gentlemen to what they attributed such a great change from the mere fact of an English education, the answer had always been: "It has freed us from the thraldom of authority." Could anybody deny that that was a perfectly legitimate deduction from English literature? Was not English literature, from the time of Queen Elizabeth down to the present day, one long pæan of liberty and the exaltation of the duty of private judgment? That being so, was that going to be arrested by anything short of stopping English education altogether? That he thought was out of the question. Secondly, was it thought that the giving of religious education was going to arrest that stream of thought and new ideas which were surging through India? His own experience was that the old orthodoxies were crumbling away, and that they were perfectly powerless to resist the stream of modern thought. He had had a good deal of experience in regard to religious education in India, and if anybody imagined that the very strong public opinion which existed in Aligarh was due in any way to religious education, he felt it his duty to reply that it was not. The influence of religious education at Aligarh had been very small. What had been very powerful, and what was a great engine for good, was the tone and the traditions of the place, which he believed could only be got in a denominational institution.

Sir J. D. Rees, K.C.I.E., C.V.O., thought that one, at any rate, of the texts from which Mr. Hill had preached needed no emphasising, namely, the fact that a certain class of education—which did not need pointing to—was a powerful solvent of the Hindu—he would not say of the Mohammedan—religion. He remembered some time ago, when he was on the staff of the Governor of Madras, going to the borders of the Presidency over which the Chairman had ruled with such distinction, where there was a forest in which were some deserted idols. It was a beautiful forest, with gushing fountains, blue sky, sparkling sea—everything that was beautiful and romantic. He asked the Governor to go and see the idols and the deserted temple. On going the next day, they found the idols had been anointed with oil and flowers strewn before them. The Governor asked what it all meant; he had been told that it was a deserted temple. The tehsildar replied that he had had the idols washed and worshipped especially for the Governor's inspection! On being asked what his own view of religion was, the tehsildar replied: "Having received an education of an English character in a University, I have no religion left." He also vouchsafed the information that a Government officer had no time for religion. He (Sir John) did not put that gentleman forward as being a type of the product of English education, and it might be that Sir Theodore Morison would say that what was the matter with the tehsildar was that he had not had education enough. But there was a moral in his story. When he was at Whitechapel a few nights previously, preaching anti-Socialism and talking about India, he found the people in that district evidently thought that the products of English education who came home here and pretended to represent India really did represent the inhabitants of that vast sub-continent, and at any rate they were people who invariably had lost their own religious beliefs. That was a very important matter, and he agreed with Mr. Hill and not with Sir Theodore Morison upon that point. He remembered that when the Reformers, that peculiar product and fine flower of new education, began to get powerful in India, the greatest plank of their platform was the renunciation of Hinduism. He could

quote authorities to prove that that was their attitude in the beginning. They did not maintain that attitude, nay, they deliberately renounced it, and were now revivalists of Hinduism. Everybody would admit that those who had received an English education in India were making admirable public servants. But the theory put forward by Sir Theodore seemed to imply that the public servants in India, and in particular the judges, were not to be depended upon, and were not honest, unless they had received an English education. From that view he entirely dissented. He believed there were men who were as honest and as upright amongst the Indian and Mohammedan peoples who had not received such an education as amongst those who had. For his own part he did not believe that the morality of the one class was superior to that of the other. Sir Theodore had also said that the result of English education was to free the Indian from the thraldom of authority. He (Sir John) admitted that was the result, but he also claimed that that freedom from the thraldom of authority had been carried to a dangerous extent, and liberty had degenerated into license. He believed that the measures suggested by Mr. Hill would have an admirable effect, and that they would not arrest, as Sir Theodore said, the stream of thought which had set in a certain direction. He (Sir John) believed that the stream could not be altogether arrested, but might be diverted, and that the adoption of Mr. Hill's suggestions would control and turn it into a new channel, with very great benefit to those who underwent an English education. He could not help dotting the i's of one suggestion of the author's. Mr. Hill said that the measures he suggested could probably be carried out with greater ease on account of the admirable tolerance of the peoples of India. There were many things in which the inhabitants of India set a good example to the people of Europe, but in nothing more than toleration. An Education Bill could not be brought before the House of Commons without violent disagreement among the Churches. In India, however, there had been no difficulty arising from the fact of the Hindu and the Mohammedan being in the same school. So far from there being any intolerance, both the Hindu and the Mohammedan united in giving the highest honorific ecclesiastical title they possessed to the English missionary, who did not always imitate that tolerance. He favoured Mr. Hill's suggested Commission.

The Rev. Dr. J. E. Marks said he knew very little with regard to education in India, his life having been spent in Burma, but there was a great deal with regard to education in India which was applicable also to the Province of Burma. It had been his lot to work in that province as an educationist and as a teacher for over forty years, and he hoped yet to return there. Although he agreed generally with the paper, there was one point which he thought the author had missed, namely, that the Government, while it properly abstained from interfering with religion in Indian schools, should be careful to be perfectly impartial in its patronage of the education carried on by missionaries and private institutions. In Burma there was a well-educated population; there were no illiterate people, and the Burmese knew their religion well. Buddhism, while it made every boy a pupil and every man a teacher, was marvellously tolerant of every institution. He went to Burma in 1859, an unknown man, and poor, as a missionary always was. The Burmese built for him colleges and schools all over the country; he had never had to ask a penny from England on that account. The result was that he had taught fifteen thousand of the boys of Burma. As an instance of Burmese toleration, he might mention that the King of Burma, hearing of the schools in Lower Burma, invited him to the capital, Mandalay, and there built for him a grand school, a church, and a house for his residence, and sent nine of his sons to the school to be taught. The King, Mindorn Min, said to him: "I do not say that I wish to become a Christian, but I do acknowledge that your nation is the strongest that has ever come to Burma. You have conquered the Burmese, which no other people has ever done, but although you have conquered them, you have not made them slaves, as others would have done; you have given them equal rights with yourselves in your courts and in your markets and in your private intercourse. You tell me that the secret of your justice and of your might and of your kindness lies in your religion, and I wish my sons to learn that religion." Yet that king was the recognised Defender of the Buddhist faith. The Burmese kingdom was now at an end; and what had happened? The Chief Commissioner of Burma, Sir Ashley Eden, had tried to smash the college—St. John's College, S.P.G.—in Rangoon. That gentleman had written saying that unless it was sold to Government, Government aid would be taken from it—one-half the first year, two-thirds the second year, and everything the third year. Sir Ashley Eden wished to ruin the college "lest it should be a rival institution" to the secular college. He (the speaker) refused the terms utterly, and declared that it would never be sold to Government, but that it would continue as a Christian missionary college. That same spirit had gone on increasingly in Burma. No effort had been made to kill such colleges, but the authorities had tried to let them die. They had tried so to make a distinction between the Government secular institutions and the missionary institutions, that people should see the difference, with the result that the Christian missionary schools, which the people loved, had the greatest difficulty in maintaining themselves. The people of India were thoroughly tolerant; and if only the Government would be impartial to such Christian missionary schools, and give them fair play and the same advantages they were giving to the secular schools, he was quite sure that the difficulties which the author had so well and properly pointed out would in a great degree vanish.

Mr. M. T. Kaderbhoy desired to refer to the question of compulsory education, which, if it was to be of any use in India, must be very carefully considered in all its aspects. Compulsory education in India would present many difficulties to an Indian, who would fear the introduction of such a system, thinking it would deprive him of his own particular education, which was based on Eastern learning. If a system of compulsory education was introduced in India, it must be either completely English or completely Indian, otherwise it would turn out Indians who would neither be a credit to their own education nor to the new system of education. He sincerely trusted the Government would seriously consider whether the suggestion would be generally approved of by Indians.

Mr. R. A. Leslie Moore said he failed to see that Dr. Marks's observations with regard to Burma had anything to do with the paper, seeing that the paper was confined to India. He, however, believed the fact to be that the Government—in India, at all events—had shown fair play to missionary schools. He also thought the remarks of the last speaker were outside the paper, which dealt with the religious aspect of English education. Sir Theodore Morison had said that the high tone of the Aligarh College was not owing to religious teaching, but to the traditions of the place; but he would ask Sir Theodore: How had those traditions sprung up if they were not the outcome of religious teaching? They were probably as much due to the tenets of the Koran as modern civilisation in Europe was to Christianity. Sir Theodore Morison had also said that English education—by which he presumed Sir Theodore meant education given by the Government of India in India—had produced a very incorruptible body of Civil servants. That was in the main true, but Sir Theodore had omitted to notice that it was that same education which had produced the frightful crimes that had occurred in India during the last few years. He (Mr. Moore) was, however, thoroughly of opinion that if Mr. Hill's scheme of religious instruction could be taught when the minds of the pupils were fresh and plastic, the result would be that the rising generation would recover that self-restraint and that respect for authority which had marked the generations that had gone before, and which had resulted in a race marked for its moderation and courtesy. Stress had been laid upon the necessity for the impartiality of the Government in Indian education. Was it not possible for the Government to maintain that impartiality by fostering all kinds of religions? He thought it might be interesting if he read a resolution of the Maharaja of Mysore on that point. It was as follows: "The time to be given to religious and moral instruction will be limited to five periods a week, the first thirty minutes after roll-call being devoted thereto. There will be a moral discourse on Mondays, Wednesdays, and Fridays, and religious instruction on Tuesdays and Thursdays. The moral discourse will be common to all persuasions, and based on a text taken from some religious, moral, historical, or literary book. In addition, there will be specific religious teaching from books like the *Sanatan Dharma* advanced text-book, the Koran, and approved commentaries and essays on the Mohammedan religion and the Bible." That was an order of an Indian prince with regard to the education of the children of all his subjects, not only Hindus, but Mohammedans and Christians. Was the example too high for imitation by the Government of British India? With regard to the teachers, he was well acquainted with many of the primary schools of the Bombay Presidency. In those schools the monthly pay of the assistant teacher was often seven rupees—9*s.* 4*d.* He asked the members to imagine the guides, philosophers, and friends of the Indian school-boy on 9*s.* 4*d.* a month! He would like to make a suggestion in that connection, namely, that less should be spent on bricks and mortar in erecting schools through the costly agency of the Public Works Department, who worked well but expensively. He suggested that the buildings should be erected by the villagers themselves, with the aid of local board overseers, and that the surplus should go towards the better remuneration of the teachers.

Mr. Reginald Murray sympathised most cordially with the author's suggestions as to the question of moral teaching in India, if explained and demonstrated by capable lecturers. He felt sure that such teaching would be acceptable to all sects and would offend none. He might recall, as an example, a Hindu of high caste, a strict Brahmin, most regular in his daily religious observances, who habitually carried about with him a volume of the "Christian Year," much of which he knew by heart. The reason he gave was that the thoughts in the book were so beautifully expressed that they aided him greatly in his meditations. With regard to the supposed difficulties which occurred between religions, one had only to look at the bridge which was being made over that great chasm which had separated for so many years science and religion in this country. If a bridge could be constructed over such a broad gulf as that, surely there could be no difficulty in bridging over the small clefts which divided the religions of the world. With regard to education generally, he might refer briefly to his own experience. He had found most of the young Indians applying for clerkships fairly efficient in handwriting and simple arithmetic, but ignorant of everything else. They lived at some distance from the offices in which they were employed — an economical necessity — so that their employers could do nothing to assist them in furthering their education. He would suggest that those young men might be encouraged to continue their education by means of evening classes in the districts in which they resided. No expensive buildings would be required, and the fees of instructors would be paid partly by

the students. He thought employers might not be averse from supplementing the fees with the prospect of improving the efficiency of their staffs, the instructors being appointed by the Government and being well-paid and capable men. The great advantage of such a system would be that book-learning and theoretical knowledge would become adjuncts to practical experience—a very desirable combination.

Mr. Syed Abdul Majid, LL.D., considered that if a measure were adopted giving compulsory education to Indians in the religions of their forefathers, grave consequences would follow. In the first place, it would give rise to a priestly class, and if history taught anything, it taught that if that class was in power, the march of progress was hampered and kept back. When the Government scheme was being introduced into India, a great deal was heard about the depressed class. There were about sixty-one millions of people who had been kept down by the priests in India. Their condition could only be improved by education, but if that education was given into the hands of the priests, their condition would remain as deplorable as before. Religion, in itself good to a great extent, was not an unmixed blessing; it always created class differences. The one policy of the British Government should be, whether with Hindus, Mohammedans, or Parsis, to create one nation called the Indian nation, and that evolution could not take place unless and until all those classes received an entirely European education. People asked the question: How do you account for the unrest in India? It was not because Indians had forgotten their religion. Indians had been taught, as it were, purely on a literary basis; they had been taught Shakespeare, Milton, and Tennyson, but they had not received any technical education at all. The very end of education was to create happiness and comfort, and if the British Government really aimed at educating the people of India they should handle the question in a more serious way, and give them the education that they really required, namely, technical education. The people would then be able to earn their livelihood much better than they were at present able to do, and such a system would do away with all the prevailing unrest. He challenged any person to name a single Indian who had received a high education who was not a supporter of the British Government. The best supporters of British rule in India were highly-educated Indians. The unrest existed among those who could not get enough to live upon because the economic conditions of the country were not developed.

Sir William Lee-Warner, G.C.S.I., in proposing a vote of thanks, remarked that the treatment was as excellent as the subject. The question was one of high and immediate importance, and the issues raised by Mr. Hill were precise and thoughtful. Whether moral instruction could be torn out by the roots from various religions, and still germinate and fructify principles of life and conduct, he was himself more than doubtful. But he would not enter into a discussion at that late hour. The whole subject needed thought, and above all an expression of the opinions of leading Indians upon the issues raised. Sir Theodore Morison had hardly touched them. Dr. Marks had contributed a useful suggestion, for many thought with him that aided enterprise needed more fostering care and fairer treatment for purposes of development. Dr. Miller's recent contribution to this subject deserved the careful attention of all. Mr. Kaderbhoy and the last speaker seemed to have introduced a new subject, but perhaps their speeches were meant to enforce the need of caution, on the ground that if Government made education compulsory their motives would be misconstrued if they introduced facilities for religious teaching. Perhaps that might be the case. But compulsory education was a very long way off, and if introduced now half the existing schools would be starved to death owing to the loss of fee income. The Society owed much to Mr. Hill for his paper, and to Lord Northcote for presiding and contributing some really valuable thoughts to the discussion. He was confident that the meeting would express its hearty thanks to both the Chairman and Mr. Hill.

Sir James Wilson, K.C.S.I., in seconding the resolution, said his experience of the subject had been confined to the Province of the Punjab, but in a matter of the sort under discussion there was not, perhaps, so great a difference between the various provinces of India as there was in other matters. In the Punjab there were Hindus, Mohammedans, and Sikhs, all differing in religion and all very anxious that their children should be taught their own particular religion, but, notwithstanding that, they were extremely tolerant amongst themselves, so long as no one attempted to convert their children or relatives from one religion to another. He thought the Government was bound to take that strong feeling of the people with regard to their religion into account, but it was quite possible for the Government to be neutral and impartial without ignoring religion altogether. He had been very much struck by the phrase which Sir Theodore Morison had quoted—that one effect of our education in India had been to free the people from the thraldom of authority. That, he thought, was the great fault of the present system. It seemed to him that history showed that the majority of people, not only in India but elsewhere, were better under a certain amount of authority, and that children and young people should be taught to obey their parents and teachers, and spiritual leaders. With regard to the question of moral training, he agreed with Mr. Hill that it would be very useful indeed to have a manual of moral instruction drawn up somewhat on the lines of "Youth's Noble Path." He did not think it would be at all difficult, even where people differed so much in religions, to draw up a moral education manual which would be acceptable to all parties;

but he would go further and say that the Government ought to make the teaching of religion—a all events, in the primary schools—easy for the parents. The Government, with its district boards and municipal committees, should organise a system of religious education, subject to inspection, and so help the parents to have their children taught the religion which they wished them to be taught.

The vote of thanks was put and carried.

The CHAIRMAN said he had been very amply repaid for his trouble in attending the meeting by hearing such an excellent paper and the very interesting comments on it.

Mr. HILL, who was prevented by the late hour from replying at the meeting to the discussion, writes as follows:—I am extremely grateful for the kind reception which was given to my paper, whose unavoidable length, I fear, curtailed the discussion which might have proved of greater value than the paper itself. It is most gratifying to me to find that the views I put forward meet with such general acceptance at the hands of Sir Theodore Morison, Sir John Rees, Sir James Wilson, and of the Chairman, and only a few words seem to be called for in reply to the remarks of the first-named, and to remove what appears to be a misunderstanding on the part of Messrs. Kaderbhoy and Abdul Majid. If I understood Sir T. Morison correctly, his contentions were—first, that English education had wrought a wonderful revolution in the standard of public morality and honesty in India; secondly, that the religious instruction imparted in the Mohammedan College at Aligarh had had little or no influence upon the students; and, lastly, that it was the tone set at that institution which brought about its satisfactory results. In regard to his first point, I am content to leave the question in the position in which it was placed by Sir John Rees; only observing that my paper nowhere attempted to suggest that English education had been devoid of results, or should be superseded by a radically different system. The position, as it presents itself to me, might be illustrated thus: In our educational system we have an excellent piece of ordnance, of sound metal and, on the whole, excellent workmanship. But its sighting has been found to be defective. In cases where it hits the mark its execution is admirable; but, owing to the defect in the sight, it sometimes misses its objective. The aim of my suggestions was, not to scrap the gun, but to remedy what is so universally recognised as a defect. I do not think that Sir T. Morison's view as to the absence of influence of the religious teaching in the Aligarh College would be supported by others who have been connected with that institution; and the impression I have derived from conversation with His Highness the Aga Khan and other influential Mohammedans is directly at variance with the views enunciated by Sir Theodore. And when it is claimed that it is the "tone" of the institution which accounts for the superiority of its products, I should like to inquire what cause it is that induces that tone. Mr. Abdul Majid, following Mr. Kaderbhoy, who dealt with the urgency of an extension of education, urged strongly that religious instruction should not be made compulsory. I fear that I cannot have made sufficiently clear the policy which I ventured to advocate. That policy involves, as a condition precedent to the introduction of moral instruction, what may be called "local option"; and, further, leaves to parents the choice whether their children shall, or shall not, be compelled to attend the religious or moral lessons. I think this explanation will remove Mr. Abdul Majid's anxiety.

Mr. EDWARD GILES, C.I.E., late Director of Public Instruction, Bombay, writes:—It appears to me that it is possible to agree and to disagree with nearly all those who spoke on this subject. Mr. Hill put his case ably and moderately before the meeting in his paper, but it struck me that he argued too much on the presumption that a secular system of education had not only produced unsatisfactory results, but was mainly responsible for that condition of unrest and for the worst form of political agitation which is so much to be deplored. He appeared to ignore the fact that a development of political and social unrest has taken place of late years in all the leading countries of the world, and that it is impossible that it should not, in these days of rapid communication and constant intercourse between nations, have affected India largely. He also, I think, failed to appreciate the enormous harm which has been done in India by a vernacular press, which has for many years exceeded all the moderate limits of decent journalism, and which has not ceased to depreciate and throw dirt at the Government of the country. Such a demonstration of license, so contrary to all the customs and traditions of Oriental rule, has, in my opinion, done far more to undermine and upset the native mind than the mere absence of direct religious teaching in the schools. And the press has been assisted by political propaganda of the worst kind, deliberately preached and insinuated by certain bodies of malcontents in various centres. Not long before I left the Bombay Presidency, the Principal of the large Vernacular Training College * at Poona, a noted centre for the exercise of Mr. Tilak's energies, came to me, and with tears in his eyes deplored the fact that young men, who left his college to be teachers in primary schools, were exposed to the direct influences of Mr. Tilak and his associates, who did all in their power to lead them astray while they were young, and to induce them to use their position in a village school for the diffusion of disloyal sentiments among the village people. It is well known that in the Deccan and in the Central Provinces Mr. Tilak's lieutenants and followers are neither few in numbers nor weak

* It sends out some sixty to seventy masters annually.

in influence. Similarly, from Bengal for years emissaries of the extremist party have been active all over India, coming as far as Ahmedabad in Gujarat, and Sindh, with the express purpose of disseminating their views and of stirring up discontent. It is well known also that in many places, and certainly in the Punjab, the propagation of political theories of the worst kind has been the work of so-called religious societies. I would ask whether this development in India could ever have been prevented by the inclusion of religious instruction in the institutions for which Government is either directly or indirectly responsible? Sir Theodore Morison appeared to me unduly to depreciate the influence of religion in the case of the Aligarh College. I should prefer to think with Mr. C. W. Waddington, the able Principal of the Mayo College at Ajmir, who showed me his 150 Rajput boys of princely blood going twice a day to prayers in the temple in the grounds, and expressed the opinion that it had an excellent influence on them after the stress of work and play, and in the early morning as a commencement to the duties of the day. But this is an exceptional case, and it must be remembered that among the Hindus generally there is no direct religious teaching or preaching, even in the temples, and that the individual attends a temple for the recital of prayer and the performance of ceremony, and not to listen to the exhortations of a preacher. This fact must always be borne in mind when we are criticising the secularity of our State schools. In Poona, when I wished to provide direct religious teaching for the Hindu boys of the Jerowda Reformatory, I was informed by such an authority as Dr. Bhandarkar that it would not be possible to obtain the services of a Brahmin priest to instruct the boys in their religion, unless he was very well paid for it!

The moral text-book offers a very inadequate solution of the difficulty. In 1883, Mr. Justice Telang, one of the ablest members of the Educational Commission, directly opposed the introduction of a moral text-book, and though the Commission recommended its preparation the idea was finally abandoned. Mr. Gould's effort to prepare such a text-book may be successful. If it is, I should certainly advocate its translation into all the vernaculars and its use in all schools, not as a lesson to be learnt by heart, but for teaching to be given perhaps once or twice a week. No harm could come of such procedure, and presumably good would result, if and so long as the teaching was intelligent and did not degenerate into vain repetitions. The constant use of moral phraseology and the repetition of religious maxims may defeat its own purpose, and we may arrive at last at the state of Thackeray's hawker in the streets of Constantinople, whose cry was, "In the name of the Prophet! Figs!" The gradual improvement of the teaching, however, is, perhaps, an existing fact in India, and, if this is so, the hope for the proper application of a moral text-book may be allowed to strengthen; nor was it necessary for Mr. Leslie Moore to speak disdainfully of a teacher on seven rupees per mensem, for that is, in the Bombay Presidency, the salary of the lowest assistant in a school, who will hardly, under proper direction, be entrusted with the exposition of the moral text-book. If such can be produced, worthy of universal adoption, I agree with Mr. Hill that the experiment should be tried.

But I have far more faith in the native of India than some, apparently, of the speakers, and I think that, in the whole discussion, there was a tendency to forget that behind the noisy band of agitators and sedition-mongers there lies the enormous mass of people who are quiet, orderly and contented. I have great faith in the character and religious impressions of the people themselves, and I have still more faith in the loyal servants of the Government, whose efficiency strengthens annually, and whose devotion to duty is, according to my experience, equal to that of any Western community. For thirty-five years I was continually among the people and among their teachers, from the heads of colleges and high schools to the masters of little village schools, and I have seen how nobly they work and how zealously they do their duty. Among so vast a population there will always be some, many even, who are bad, but the vast majority are good, not through European teaching and example only, but from their own inherent and hereditary characteristics. As India advances in material prosperity, in enlightenment, and in the knowledge and appreciation of true political progress, the necessity for direct moral instruction will, I imagine, become less apparent, and the increasing power of public opinion, the development of communications, and the interweaving of interests will produce a community more and more closely knit together, and more and more susceptible to those influences which make for truth, peace, justice and right. India, under a settled and powerful rule, will work out her own salvation, or will, if that rule is relaxed, be lost in one gigantic convulsion, which will not be delayed by the application of a moral text-book.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 22nd, 1911; Professor John Millar Thomson, LL.D., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Curtis, Professor Mattoon Monroe, A.M., Ph.D., 2045, Adelbert Road, Cleveland, Ohio, U.S.A.

Farrington, Henry, M.Sc., B.Eng., Popular Mechanics Company, Chicago, Illinois, U.S.A.

Howarth, Joseph, Kirkdale, Oldfield Lane, Dunham Massey, near Altrincham, Cheshire.

Samaddar, Professor Jogindra Nath, B.A., The College, Hazaribagh, Bengal, India.

The following candidates were balloted for and duly elected members of the Society:—

Barnes, Carl L., M.D., LL.B., 1977, Ogden-avenue, Chicago, Illinois, U.S.A.

Carroll, Alexander Ernest, Assoc.M.Inst.C.E., 7, Appion-way, Dublin, Ireland.

Crump, Colonel Malcolm Hart, Room 2, Elks Building, Bowling Green, Kentucky, U.S.A.

Darling, Charles Robert, Beechurst, 186, Eglinton-road, Plumstead, Kent.

Field, George Moyle Robert, M.Inst.C.E., 203, Coleherne-court, South Kensington, S.W.

Goldschmidt, Dr. Hans, 98, Bismarckstrasse, Essen-on-the-Ruhr, Germany.

Mason, Frank, M.Inst.M., 37, Carrington-road, Endcliffe, Sheffield.

Pitkin, Rev. John, Shapwick-cum-Ashcott, near Bridgwater, Somerset.

Wale, Charles, 8, Great George-street, Westminster, S.W.

The paper read was—

THE MANUFACTURE OF PORTLAND CEMENT.

By A. C. Davis, F.C.S., Assoc.Inst.C.E.

Although I propose in this paper to confine my subject particularly to the methods of manufacture as adopted in the industry in this country, yet the progress that has been made in recent years by manufacturers of Portland cement on the Continent and in the United States of America and Canada, will call for comment where such progress differs materially from our own methods.

At the present time, however, the British cement-maker generally is as up-to-date in his methods of manufacture as any of his competitors over the world, but it has only been within the past ten years that we have awakened to the seriousness of foreign and home competition, and have aroused ourselves from the undesirable state generally arising from affluence and inactivity.

Portland cement was originally invented in England some three-quarters of a century ago, and the British makers adhered solidly to old-fashioned methods for some decades. These at last had their day. But whilst we were dormant, our foreign rivals not only copied the manufacture of this invaluable product from us, but actually improved upon it to such an extent, that their industrial conditions, as far as cement-making is concerned, have been a revelation to us. For some years, however, the British cement-maker has been actively engaged in building modern works and putting down up-to-date plant in his obsolete factories, with the result that for quality of product, combined with low cost of production, the British manufacturer has nothing to fear from oversea competitors, and British Portland cement to-day has no rival in quality the world over.

The debt which we owe to Portland cement is hardly recognised as widely as it should be. Its invention alone has rendered possible many of the extraordinary architectural, and more especially engineering, feats of the last century, its durability far exceeding iron, bricks, and building-stone. Its present excellence is the outcome of years of patient scientific investigation and study, and although the names of those inventors and perfecters who laboured principally during the first half of the nineteenth century are forgotten, or at least but dimly remembered, the result of their work has originated and assisted design to an extent as great as, or perhaps greater than, has the introduction of mild steel for constructional purposes.

The application of cement in general construction covers so wide a sphere of influence that each year finds it successfully employed for some new work, and numerous evidences of this point to the great strides which have been made during recent years in the science of the manufacture of this invaluable product.

Bridges, breakwaters, docks, canals, dams, reservoirs, cement-concrete streets and footpaths, with their remarkable neatness and evenness, together with partitions, roofing tiles, building blocks, boats, barges, and caissons, and to-day entire buildings (such as the new Royal Automobile Club and the new General Post Office) represent a few of the important works constructed with Portland cement. These illustrations mark but the beginning of the era of cement in the field of engineering and architecture.

As to the permanence of works executed in concrete, this has been very fully recognised from ancient times.

Vitruvius Pollio, a celebrated architect of the time of Augustus, Emperor of Rome, describes concrete as one of the most valuable building materials which for centuries before his time had been used for foundation walls and all structures where great strength was required.

The great dome of the Pantheon in Rome, 142 feet in diameter, was built entirely of concrete, and remains to this day an example of durability, having resisted the destructive

influences of Nature for well-nigh two thousand years.

The cementing material of past ages, however, was no doubt more akin to what we now know as hydraulic lime than the comparatively modern product, Portland cement.

As to the history of cements, the first information we can find in regard to the discovery of this product or its allied materials is in the records left by that eminent English engineer, John Smeaton, who, during the construction of the third Eddystone Lighthouse in 1757, discovered that a calcined mixture of lime and clay possesses the property of hydraulicity. It is reasonable to suppose that the material which Smeaton then prepared was what we should term an hydraulic lime.

L'ttle notice was, however, paid to Smeaton's discovery, and some fifty years later the French chemist, Vicat, followed Smeaton's observation to its natural and logical conclusion, and made another step forward in burning together finely-pulverised chalk and clay, after having mixed them into paste. His process, however, received little attention.

In the year 1824 we have the practical commencement of the manufacture of what we know to-day as "Portland" cement, when the English mason, Joseph Aspdin of Leeds, found that by mixing in certain well-defined proportions finely-pulverised chalk with the clayey mud of the River Medway, and burning the same at a high temperature, he was able to produce a hydraulic binding far exceeding in quality any product known up to that time. This material possesses the delicate grey colour of Portland *stone*, and thus received the name of "Portland" cement, which formed the subject of Aspdin's oft-quoted patent of October 21st, 1824.

It is safe to assume that the Thames Tunnel, constructed in 1828, was the first engineering work of importance in which Portland cement was used. The price at that time, by the way, was 21*s*. per cask at the works, while to-day a far superior quality product can be purchased at some 4*s*. per cask, so much have the conditions of the industry altered in the past three-quarters of a century.

Now, what is Portland cement? The term "Portland" is limited to a hydraulic cement containing a large percentage of lime, and at once distinguishes the valuable constructive material bearing that title from other cementitious substances.

As the classifications of hydraulic products vary, so do the definitions of Portland cement, and the opinions as to what shall be included in the term. To be perfectly clear, then, as to what Portland cement actually is, I may perhaps refer to the official descriptions of the product in the largest cement-consuming countries, viz.:—

The British Standard Specification defines Portland cement in the following terms: "The cement shall be prepared by intimately mixing together calcareous and argillaceous materials, burning them at a clinkering temperature, and grinding the resulting clinkers."

The Association of German Cement Manufacturers defines cement, generally, as follows: "Portland cement is an article produced from an intimate mixture of the materials containing lime and clay as principal ingredients, burnt to a clinker, and afterwards ground to the fineness of flour."

In the French Government Specification Portland cement is defined as: "The product of the grinding of clinkered rock, obtained by the burning to the point of softening of an intimate mixture of carbonate of lime and argillaceous matter, rigorously combined and chemically and physically homogeneous in all its parts."

The American Standard of Portland cement defines the term as: "The finely-pulverised product resulting from the calcination to incipient fusion of an intimate mixture of properly-proportioned argillaceous and calcareous materials, to which no addition greater than 3 per cent. has been made subsequent to calcination."

It will thus be seen that from a study of these various descriptions we really arrive at the point that Portland cement is a chemical product obtained by the preliminary mechanical combination of carbonate of lime with silica and alumina, which, after passing through the succeeding stages of manufacture, becomes a mixture of silicates and aluminates of lime.

The centres of the manufacture of Portland cement are well distributed over the country, as will be here seen from the map which has been prepared to show the location of cement factories in England.

The normal size of a factory is one having an output of some 500 to 1,000 tons of Portland cement per week, and in this country alone we have some eighty cement companies with a total output of some 3,000,000 tons of cement per annum, which is equal to 15,000,000 tons of concrete or 8,350,000 cubic yards—the contents of a wall 6 feet wide, 20 feet high and 350 miles

long, which could only be constructed at a cost of five million pounds sterling.

Portland cement can be produced from any raw materials containing constituents capable of yielding by calcination the silicates and aluminates of lime which form its chief components, and the necessary constituents of these raw materials are lime, silica, and alumina. Small additions of iron oxide are desirable for fluxing these materials.

The raw materials used for the manufacture are therefore carbonate of lime, usually in the form of chalk or limestone, and silica and alumina, usually in the combined form of shale or clay. The two materials for the necessary combination indispensable for the manufacture of cement are not always found upon the same site. For the Thames and Medway works, as an instance, a usually flinty chalk deposit is found on the site where the works are situated, and this, together with mud taken from the Rivers Thames and Medway, is used in the manufacture. On the other hand, the Cambridgeshire works are able to obtain from one deposit the necessary raw materials for the manufacture of Portland cement.

The suitability of locality depends upon the manner of the occurrence of these requisites, the location of the deposit with respect to the cement-consuming market and the fuel supplies; for since with every ton of cement manufactured there will be used half a ton of coal, the location of the factory in regard to cheap fuel supplies is quite an important factor.

If it were at all possible to find a geological formation of uniform composition containing exactly the right amount of naturally-mixed chalk and clay, Portland cement could be made from it by the cheap and simple method of merely burning lumps of the material as quarried. But since such a material has not been discovered in quantity in this country, this method of manufacture is hardly practicable, for a variation of even 1 per cent. of the proportion of carbonate of lime in the raw materials, to say nothing of the irregular composition of the other ingredients, is sufficient to destroy the reliable quality of the resultant cement.

In manufacturing Portland cement, however, carbonate of lime and clay are first efficiently and accurately amalgamated in certain fixed proportions, either by the addition of water to the raw materials, or by the fine grinding and mixing of the same in their dry state.

The composition of a prepared mixture of these raw materials should be, roughly, three parts of chalk to one of clay.

The various raw materials employed in the manufacture of Portland cement at the present day may be described as follows:—

In the Thames and Medway districts the chalk formation on the banks of these rivers is quarried, and this material is mixed with the deposits of mud found in the estuaries and creeks. These chalk deposits have a depth of 100 to 300 feet, and the excavation is done by manual labour. The greater part of the clay used by the Thames and Medway manufacturers is this alluvial mud I have referred to, which is a salt-water deposit. These two raw materials are mixed together in correct proportions by what is called the wet process of manufacture, to which I will refer later.

The chalk marls around Cambridge have been well proved to be eminently suitable for the manufacture of a first-class quality cement. The "marl" is a deposit of calcareous and argillaceous material found at the base of the local chalk. It differs from the main mass of the chalk above in the quantity of the clay it contains, as might have been expected, seeing that the chalk deposit succeeded a deposit of fine gault clay, and it is probable that during the changing geological conditions the sea would not be at once cleared of mud.

It is a curious fact, and one worthy of note, that the chalk marl of Cambridgeshire—though the relative quantities of chalk may vary from yard to yard in depth when testing on the face of the quarry—contains in the aggregate about the same proportion of calcareous and clayey material as is obtained artificially by the mixture of chalk with alluvial mud in the Medway valley. Therefore, along the outcrop of this chalk marl, cement works have of recent years proved the value of the Cambridge deposit from a cement-making point of view. The deposit is, in the most favourable conditions, found about two feet below the surface, and runs to a depth of from 30 to 60 feet.

The calcareous content in the material, being in a measure the most valuable and most important ingredient from a cement-making point of view, is shown from various analyses to average from 70 to 80 per cent. of carbonate of lime, and the remaining constituents are exactly the amounts of silica, alumina, and oxide of iron required for the manufacture.

It is only safe, however, to treat these marls under a perfect scientific cement-making process, which I will explain later; the manufacture is

therefore so arranged that the "lower chalked" marl is intimately blended by a process of dry grinding with a material containing an excess of lime carbonate in order to produce a working average of, say, 75 per cent. $CaCO_3$. The resultant mixture is then ready for proceeding with the further operation of burning.

In the cement-making districts of Rugby and Wales, we have the well-known Lias formation of limestone and shale, and this is successfully treated for the manufacture of Portland cement. The thin layers of these materials with their variation in composition must, similarly, be very accurately and efficiently dealt with. In working the Lias formation it is found that the preponderance of shale in proportion to limestone (which is generally found to contain 78 to 85 per cent. of carbonate of lime) renders the cost of working heavy, because of the removal of surplus clayey material not required in the manufacture. This Lias formation consists of layers of impure limestone of varying thickness, ranging from two inches to two feet and parted by means of shale and clay, the total thickness of shale beds considerably exceeding, as a rule, that of the limestone, which necessitates removal and tipping the waste.

On the Tyne, Wear and Tees, and in the north of England generally, Portland cement is manufactured from chalk imported from the Thames, Medway or Sussex districts, and this is mixed with a local clay found on the site of the works. From this mixture a good quality cement is manufactured.

These descriptions, then, deal with the most important deposits of cement raw materials over the country.

In the United States most of the cement produced is from the Lehigh Valley argillaceous limestone, a sample of which we have here, and which contains rather more clay than is required for a correct mixture. To this a small amount of pure limestone, usually 10 to 20 per cent., is added to bring the mixture up to the necessary percentage of calcium carbonate required in the manufacture.

In Germany the raw material consists of chalk marl, similar to the samples we have before us.

It will thus be seen that, given chalk and clay in approximate proportions of three to one, or lime with silica and alumina in any other form, it is of the first importance that these materials shall be treated with a full knowledge of the all-important chemical and mechanical operations of combining them, which alone can secure the manufacture of a reliable product.

Now I must refer to the mixing processes by which these raw materials are brought to the condition for chemical combination, and if attention is paid to these diagrammatic sketches of the processes of manufacture my explanations will be more clear to you.

The preliminary mechanical blending of the raw materials for the manufacture of Portland cement is a stage requiring the utmost technical skill, for the thoroughness of the process primarily determines the quality of the resulting cement, and if the manufacturer is to turn out a product of reliable quality the scientific supervision of this branch of the manufacture is of paramount importance.

The primary conditions of any method of Portland cement manufacture are that the raw materials shall be (1) correctly proportioned, (2) very finely comminuted, and (3) thoroughly mixed. The proportions of chalk and clay must be kept to a standard as closely as possible, and this at the present time, in the most successful cement works, is carried out under the supervision of the works' chemists. It is firstly essential that extreme care should be exercised in obtaining the correct proportions of the chalk and clay, or whatever other raw materials may be used in the process, so that the resultant mixture may be relied upon to contain the exact chemical constituents necessary for the manufacture of a thoroughly sound cement; for if the raw materials are not mixed in this proper proportion, nothing can be done later to correct it, and the result will be an inferior product. The proportioning of the ingredients is governed by continuous laboratory checking of the raw materials as they are quarried, and this testing by the works' chemists goes on night and day, or as long as the manufacture is proceeding

The question how the next preliminary condition of the manufacture can best be fulfilled —that of the reduction of the raw materials— depends chiefly upon their character, so that the details of the methods adopted by manufacturers for grinding generally vary with the raw materials used.

Upon referring to the diagrammatic sketches I have here, and by following them with my descriptions of cement manufacture, it will be seen that there are two principal methods of reducing and mixing the raw materials, namely: Firstly, the "Wet Process," applicable only to soft materials, the correct quantities of the raw ingredients being ground and mixed with the aid of a considerable amount of water; secondly,

the "Dry Process," in which the perfectly dry materials are ground together to an impalpable powder or "flour," and subsequently mixed to correct chemical proportions.

The wet process of mixing the raw materials is particularly adapted to such materials as are easily disintegrated by the addition of water. This method of mixing, as originated and developed in this country, is employed to a considerable extent by the manufacturers of cement on the Thames and Medway—the seat of the industry. By this process the chalk, as quarried, and clay are weighed into what is called a "wash-mill," where a large amount of water is added. The wash-mill is simply a brick pit, some 15 feet in diameter and 5 feet deep, in which revolves a series of harrows for breaking up and mixing the two ingredients in their wet state. It is fitted with a circular framework revolving on a central pier, to which the harrows are suspended by chains, the machine being driven by a crown wheel which drives the heavy harrows round the wash-mill and through the material at the same time, thus agitating the mass and disintegrating and mixing the raw materials so as to bring the mixture to about the consistency of cream. In this condition it is termed "slip" or "slurry."

The thick liquid material from the wash-mill is then pumped to further grinding machinery in the shape of mill-stones or tube-mills, where the operation of amalgamation of the raw materials is completed.

The tube-mill as used for wet grinding consists of a drum (about 20 feet long and 4 feet 6 inches diameter) made of steel and protected against wear and tear by renewable cast-iron plates. The drum contains a large number of flint stones, and its interior is easy of access through two or more manholes.

The raw mixture, previously reduced by the wash-mill, flows through a simple straight pipe and through the hollow journal on to the front end near the gearing into the grinding drum, which slowly revolves. After being thoroughly ground by the flint stones, the material is discharged through the hollow journal at the opposite end into a trough, which conducts the mixed materials to the drying chambers.

In the dry process method of dealing with the raw materials for cement manufacture, the calcareous and argillaceous materials, of whatever substances they may be composed, have first to be dried after passing the preliminary crushing machinery. The dryers often take the shape of extensively constructed brickwork kilns, but with the more general adoption of the dry process of manufacture little time was lost in inventing a less costly and more efficient plant which could also be worked at a much reduced labour cost. The dryers now usually employed, therefore, in the most modern plants, consist of revolving cylinders some thirty to fifty feet in length and about four feet in diameter. These rotary drying drums, as they are termed, are supported on steel tyres resting on heavy friction rolls, and the drums are rotated, when in use, at a speed approximating two revolutions per minute, and are usually set with an inclination of about one half-inch per foot.

The raw materials, after passing the crushing rolls, are introduced into the upper end of the dryers and are immediately caught by cascading channels fitted inside the drums, which lift and drop the crushed raw materials as the drum revolves, and present them to the hot gases passing through the drums in the opposite direction to the way the materials are travelling, to the lower or outlet end. The use of the waste heat from the kilns is thus employed for drying purposes, or, again, furnaces are sometimes arranged to rotary dryers for the external heating of the drum.

The raw material, after being crushed and dried, must then be reduced to an extremely fine powder or "flour," and then carefully and thoroughly mixed to the proper chemical proportions before being conveyed to the kilns for burning. The plant usually employed for dry raw material grinding is often exactly the same as that used for grinding the finished cement, which I will describe later.

This dry process of manufacture is generally employed where the raw materials cannot be satisfactorily reduced by the addition of water. It is adopted in the Rugby and Wales districts, and in the Cambridge district also.

In America and Canada the dry process is generally adopted, and similarly in Germany the dry process of manufacture is considered a less costly process than the wet method.

It will be seen, therefore, that in preparing the raw materials for the manufacture of cement, the chalk and clay must first be reduced to the utmost fineness, either by the addition of water or by dry grinding, either of which processes breaks down the cohesion between the particles and leaves the material in a very finely-divided state, the physical properties of the respective materials to be dealt with generally determining which method of reduction is to adopted.

Now, before the prepared raw materials pass to the next stage in the manufacture—that of burning—the composition of the raw material mixture is ascertained by analyses and tests, and the carbonate of lime (familiarly known by its chemical formula, $CaCO_3$) should be kept within, at most one-half per cent. of the quantity found to produce the best cement. This percentage of lime varies in different works according to the many geological formations contributing to the manufacture, but, roughly, a combination of 75 per cent. of chalk and 25 per cent. of clay, will produce a cement of good quality. If any carelessness is permitted in the mixing process, the results are likely to be disappointing, for when the proportion of clay runs too high (or the percentage of lime carbonate falls below 75) a compound is obtained which, in the burning process, will fuse at a temperature lower than that required for the production of sound clinker, thus rendering it useless; and, on the other hand, an excess of chalk (above, say, 76 per cent.) will allow a mixture to sustain the highest temperature in the kiln without risk of fusion, but the resultant clinker would be of doubtful quality because of its expansive tendencies when ground for cement.

Again, a variation in the amount of carbonate of lime, even to one-half per cent., is found to alter appreciably the tensile strength of a cement, high lime producing high strains, and low lime, low strains.

The chemically-mixed raw material prepared in ordinary course of manufacture may, therefore, analyse in this way:—

Silica	16·5	Clay
Alumina and Oxide of Iron	6·5	
Undetermined	0·5	
Carbonate of Lime	75·5	Chalk
Carbonate of Magnesia	1·0	

From such a material, if properly treated in the further stages of manufacture, a good commercial cement, testing at least 600 lbs. per square inch in seven days, should be produced. The raw materials after combination are then carefully mixed and proved before proceeding with the manufacture.

The next stage in the manufacture of Portland cement, following the scientific and mechanical preparation of the raw material, is that of burning at a high temperature, or calcining, the raw product at a point of slight vitrifaction, resulting in what is commonly called a cement "clinker."

As will be seen from my previous remarks, Portland cement consists of a chemical combination of lime, silica, and alumina, and these materials are combined together under the action of great heat, thus becoming a mixture of silicates and aluminates of lime. The resultant material is ground to a fine impalpable powder, after which the product is ready for the market.

In the raw materials it will be observed that the carbonate of lime, silica, and alumina, are in an uncombined state; in the conversion of the prepared raw materials into cement clinker by burning, the silica and alumina of the clay immediately enter into combination with the lime, thus forming calcium silicates and aluminates.

These compounds are the important constituents of a Portland cement, and give to it, when combined in their proper proportions, its hydraulic properties. None of the cements of commerce, however, are made up wholly of these three ingredients, for the raw materials from which cement is made are never quite pure. It has been found, for instance, that iron oxide behaved in burning a mixture just as alumina, and that a good cement could be made in which all the alumina was replaced by iron oxide; but the essential elements of a good cement are that it shall contain at least the necessary amount of silica and lime.

The calcining process is a purely chemical one, and it is a state of the manufacture involving great responsibility, for just as the primary blending of the chalk and clay or faulty mixing can make or mar the quality of the cement, so can the burning of the material destroy all that is valuable in the finished product. If the temperature is too high in the kiln, the resultant material loses much of its value as a cement; and, on the other hand, if the heat be not sufficient, the necessary chemical changes do not take place, and a similar unsatisfactory result is obtained.

The proper degree of burning is indicated by the formation of a dense greenish-black clinker when coming from the kilns. Light-burned clinker is brownish and soft, while over-burned clinker is fused and slag-like.

The aggregate temperature in the process of calcination shows that, for normal Portland cement burning, a heat is required in the kiln amounting to 1,400° C., or 2,500° F. This temperature is variable, according to the percentage of carbonate of lime contained in the raw materials, the higher the proportion of lime the higher the temperature which is

necessary to produce complete diffusion in combination with silica.

The kilns for burning the raw materials are always constructed for either an "intermittent" or a "continuous" process. The intermittent kilns now generally adopted are those employed in the wet process, and are of such a design that the burning necessitates a distinct loading and drawing operation, giving intermittent working and demanding the shutting down of the kiln during the drawing operation. Since this method of manufacture is one that will soon be discarded, I will not devote any of your time to an explanation of this kiln.

But in the continuous kilns, the burning of the raw material proceeds without a break, and the drawing of the clinker takes place at the same time without interruption, thus making a continuous process.

Continuous kilns are generally costly to construct and require skilled labour for their operation. These kilns are economical in fuel, and where they are used the calcining process is much more regular and the cement is of better quality.

In the category of continuous kilns we come to the process of burning by the rotary kiln which has been lately brought into use. The manufacture of cement by the rotary kiln may be said to have revolutionised the industry, and this method of burning the raw materials is perhaps the most scientific and practical invention that has been introduced into the manufacture since Portland cement was first known. Although the use of this kiln is a technical and expensive process, involving heavy capital outlay, and high cost of production and continual upkeep, yet a considerable time must elapse before any further development will arise to outclass this invention in the manufacture of Portland cement.

More than 90 per cent. of the cement manufactured in the States is produced by the rotary kiln, and in England there are numerous works in which the kiln is solely adopted. Its use in all directions is also daily increasing, and many other factories, not only in this country but in many parts of the Continent, are now installing the rotary kiln for cement burning.

Although perhaps a new method of cement manufacture, enough has been seen of the product made from the rotary kiln, both in science and practice, to declare it to be the product of the future. The rotary kiln consists of a slightly inclined steel or wrought-iron cylinder, usually from 100 to 150 feet in length, and 6 to 8 feet in diameter, and it is inclined to the horizontal at about 1 in 30. The kiln is lined with radial fire-bricks, some 9 inches in thickness, and the long cylinder is mounted on tyres running on rollers and slowly rotated by gearing.

The cement-making materials are continuously fed into the kiln through a pipe at the upper end, in the form of either liquid mud or dry powder, according to the process adopted in preparing and mixing the raw materials. Finely-ground coal is almost always used as fuel, and this is introduced into the lower or outlet end of the kiln by a jet of air issuing from a blast fan.

When the kiln is started the fine coal is ignited, and after a time a white heat is obtained in the lower end of the cylinder. The raw material is then fed into the kiln, and as it gradually descends into the zone of heat generated by the perfect combustion of the finely-ground coal fed into the cylinder from the opposite end, it parts with any carbonic gas, forms little rounded balls which reach nearly white heat in the lower third of the kiln, and finally issues at the lower end as well-burned clinker in grains about the size of a large pea. The greatest heat is naturally near the fuel-jet or outlet end of the kiln.

The operation of calcining is a continuous one, and with proper care under or over-burning may be avoided. The hot clinker from the kiln is cooled either by being elevated to cooling towers or by rotary cooling drums. The cooling drums now generally in use in this country are placed at the lower end of the kiln, and receive the hot clinker as it drops finally from the kiln and passes into the coolers. These generally consist of tubes some forty feet long and four feet in diameter, containing cascading channels for lifting and dropping the hot clinker as the coolers rotate, thus presenting it to the cold air drawn through the clinker by the fan discharging coal to the kilns. The coolers rotate at a somewhat higher speed than the furnace tube, and by the air for the latter being drawn through the red-hot clinker a fair proportion of the otherwise lost heat is retained and utilised. When the clinker issues from the coolers it is quite cold enough to handle, and to pass to the further process of grinding into powder.

But before this stage it is necessary to point out that all rotary kiln plants with ground-coal firing must include an apparatus for the drying of the coal to be used in the burning, and also a grinding plant to enable the coal to be finely pulverised before entering the kilns.

The most common design of coal drying consists of an inclined steel cylinder encased in brickwork. The hot gases from the fires of the coal-dryer coming first in contact with the cylinder at the point where the wet coal is introduced, pass along and around the tube on the way to the chimney-stack, which is located over the discharge end, whilst a separate chimney at the feed end of the rotary coal-dryer permits the steam from the moist coal to escape, and gives an outlet for any congregating gases or coal dust.

The wet coal is introduced at one end of the heated drying drum and by means of cascading channels inside, and the inclined cylinder slowly rotating the coal passes through the drum, and by the time it arrives at the outlet, the dried coal is quite suitable for the purposes of fine grinding for use in the rotary kiln.

From the dryer the coal falls into a conveyor, and is carried automatically to the coal-grinding mill, which contains machinery for reducing the slack coal to an impalpable flour. For the process of coal-grinding the usual ball and tube-mills or Griffin mills are required, and this plant is therefore similar to the clinker-grinding plant, particulars of which I will give you later. The finely-ground coal is then taken to the kiln-house, where it enters the coal-hoppers situate in front of each rotary kiln, and from these hoppers an automatic feed conveys the powdered coal to a point where it is met by the heated air-blast from the fan to the kiln. When reaching the heat of the kiln the powdered coal immediately bursts into flame, and the intense heat in the kiln is thus kept continuously regular.

The percentage of fuel used in burning a ton of cement by the rotary kiln is from 25 to 35, although this percentage varies considerably according to the quality of coal used and the fineness of grinding, and the facility with which the raw materials are burned.

A satisfactory coal for the rotary kiln is generally obtained from the various bituminous coals found in this country, but it is necessary to see that the percentage of ash in the coal does not exceed 10, and that the coal also has a value of some 7,000 calories per kilo, which is equal to 12,600 British thermal units per pound of coal.

We now come to the succeeding and final stage in the process, the grinding into an extremely fine powder of the clinker which comes from the kilns; and this process has exercised quite a large proportion of ingenuity during the past few years. So much attention has of late been devoted to the manufacture that, as regards the mixing of the raw materials in their due proportions and the proper calcination of the mixture so obtained, one brand of cement may be said to be very much like another, provided the works are suitably designed and the various details of the manufacture are carried out with care.

The question then arises—What constitutes a high-class cement? To this question the answer is, that the true test of quality is not to be found in the brand but in the fineness to which the cement is ground—always provided, of course, that the materials are carefully selected and the various stages of manufacture are properly carried out.

It is not intended, however, that I should deal with the scientific qualities of cement by grinding to various degrees of fineness. I propose now merely to deal with the machinery generally employed in the process of clinker reduction. It must be explained here, however, that in clinker-grinding not only is it necessary that a certain degree of fineness be attained to make a satisfactory quality of cement, but that also as large a proportion of "flour" as possible shall be contained in the finished product. By "flour" I mean that the cementitious property of the material is believed to reside principally in the extremely fine particles of cement, as apart from the "residue," which consists of practically inert material. These are terms which, as you know, are used in the testing of cement for fineness.

The first stage in the reduction of the clinker is generally carried out by an ordinary stone-breaker or crusher, or rolls, which reduce any large lumps to the size of about three-quarter-inch cubes down to coarse dust, and after this operation the clinker is conveyed to the fine-grinding machinery.

In modern works the preliminary grinding of cement clinker is carried out by the ball-mill, and from this mill the coarsely-ground material is conducted to a tube-mill which finishes the fine grinding previous to storing the cement. The ball-mill consists of a cylindrical grinding drum, mounted on a steel shaft running through it, and provided with a tightly closed sheet-iron casing. The grinding-drum is composed of overlapping steel grinding-plates, in one half of which holes are bored for the ground material to find its way through to the fine sieves externally surrounding the drum, and through which the somewhat coarsely-ground cement passes and is conveyed to the tube-mills for

finer grinding. The crushing action of the ball-mill is caused by the revolving of the drum, which contains a number of steel balls of various sizes between which the clinker is crushed and pulverised. This description will be clear to you when I am able to put some illustrations upon the screen.

For the finishing process—the fine-grinding proper—the tube-mill is employed, which grinds by means of the round flint stones contained within it. The tube-mill consists of a wrought-iron revolving cylinder with hollowed pivots at both the feed and delivery bearings, and is about one-half full of rounded flint stones. The coarsely-ground cement is fed from the ball-mill into one end of the tube-mill, and the rotary action of this mill, similarly to that of the ball-mill, finely pulverises the cement as it passes through the falling flint stones to the delivery end.

The finished cement is ground sufficiently fine to pass through a 76 × 76 mesh sieve with about 1 per cent. residue, and although finer grinding is rarely demanded, it can be readily accomplished by the manufacturer, if necessary; but this means a reduced output from the plant.

From the grinding mills the cement is conveyed into the stores, and after it has cooled down the material is ready for loading out at the factory.

As to the storage of Portland cement, it is generally considered that the longer the cement is kept in stock the more reliable it is to be found in use; but the modern product of to-day's manufacture requires neither storage nor aeration to provide and ensure the success of its quality.

With the product manufactured many years ago it may have been necessary to aerate cement for some considerable time before introducing it into the work, but with the cements manufactured to-day this is quite unnecessary. The aeration of cements is a safeguarding process adopted by engineers with important work, and was perhaps advisable to eliminate any "free lime" that might be contained in the material, as an underburnt or carelessly manufactured cement contained a considerable quantity. Cement such as this would, when mixed with water, set quickly, and sooner or later the particles of "free lime" absorb moisture and change from what is termed "quick lime" (CaO) to a hydrate of lime ($CaHO_2$), and the expansion which accompanies this change produces a disastrous effect in the hardened cement.

The old idea was, therefore, that if the cement were exposed to the atmosphere for some time before being used, any free lime which it might contain would absorb moisture from the atmosphere and would not then be liable to cause injury to the concrete after setting. But a cement made from accurately-mixed raw materials, well burnt and finely ground, as all good cements should be, will not require any aerating process, and as soon as the cement is manufactured it should withstand the recognised tests for quality immediately it is ground.

It is desirable, however, that the material should be cooled down before loading into bags, and therefore the manufacturer generally arranges that he has sufficient quantity of material in stock to provide that engineers are supplied with a perfectly cool cement for their work.

DISCUSSION.

The Chairman (Professor J. M. Thomson), in opening the discussion, confessed that the paper had taken rather a different line from that which he had expected. He had hoped to hear a little information on the chemistry of cement, particularly with regard to the rather mystical change which took place in its hardening. The present theory was still what it always was, that cement was a mixture of tri-calcic silicate and tri-calcic aluminate; but what happened to those constituents when water was added to them, and they subsequently hardened, was a question that men of science would like a little information about.

Mr. D. B. Butler said the author, in referring to the Newcastle works, had stated that chalk was carried to the northern port by colliers which brought coal to London. That statement was not as accurate as it might be, because the majority of the chalk which was carried north was conveyed in specially-designed barges, which were towed, and not in colliers. The impression made upon him by the author's remarks was that he rather decried English manufacturers for using the wet process as much as they did, because the Germans and the Americans used the dry process. Anyone who had to use a flinty chalk, such as was obtained in most instances in the Medway, would experience difficulty in using the dry process. The wet process with the wash-mill was by far the simplest method of treating such chalk, because the flints were in that way washed out almost automatically, whereas in a dry process the grinding of chalk with flint in it would introduce trouble.

Mr. J. F. Waycott said that although the author had referred to the processes adopted in America, Germany, the United Kingdom, and other countries, in the manufacture of cement, he had entirely ignored the cement produced from the Tournai Basin in Belgium. The author had stated

that good Portland cement was an intimate mixture of carbonate of lime, silica and alumina, and that, as a natural combination of those materials could not be found, it was necessary to adjust the compositions. Did the author know that in the basin of the Tournai in Belgium there was a natural rock combining most accurately practically all the constituents that were required for the manufacture of a perfect cement? Was he prepared to say that a rock which contained the requisite proportions of materials suitable for the manufacture of cement was not a Portland cement, but that Portland cement could only be made by the admixture of two materials such as chalk and clay, as was stated in the British Standard Specification? Personally, he contended that if a natural rock combined chemically all the desired constituents it should be considered a Portland cement. He was satisfied that geological formations could be found in this country corresponding to the Tournai rock which would produce a good useful cement, and he hoped English cement manufacturers would turn their attention to that subject.

Mr. Walter F. Reid, F.I.C., thought the last speaker was under a misapprehension with regard to the British Standard Specification for cement. That specification stated that the material must be an intimate mixture, but it did not say it must be an artificial mixture. If the materials could be found mixed in Nature it was an admixture. Similar deposits to those in Tournai were to be found in this country, and they had been used very largely for the making of cement; and from tests he had made of English and Belgian cements he had found that the former was not only equal, but a great deal superior, to much of the latter. The material in the Cambridge district was composed of a similar natural mixture, and the author had very clearly explained how uniformity was obtained from the natural layers in which the composition was not uniform by taking materials from different parts of the quarry and mixing them under the supervision of the chemist, so that the ultimate result was absolutely uniform. He was instrumental many years ago in starting a cement factory in the Rugby district, and no engineer worthy of the name now rejected a Rugby cement if it otherwise came up to the standard. When the first Rugby cement factory was started he analysed the whole of the layers, and found there were considerable differences in them, and ever since it had been necessary to mix the different layers of limestone in certain definite proportions. The layers were also full of fossils, and these were very often fossilised in the form of pyrites, which were sometimes very troublesome. They gave a great deal of sulphur in the cement, which formed a sulphate in setting; but the material was dug out so carefully that the Rugby cement was now second to none in the country. It was quite true that this country had learned a lot from Germany since Germany, in the first instance, learned the lesson from England. There were many instances in which England taught Germany her first lesson, and when that country had learned to spell she had written out whole treatises for the English to learn from afterwards. Of this the aniline dye industry and the cement industry were striking examples. It was amusing to look back on the form of testing employed in the old days, when in every cement factory there was a sampler, who took a certain quantity of slurry as it came from the wash-mills, put it into a little vat, stirred it up, and twice a day would make little cakes of it in a small drying-oven, which were then burned in a sample kiln, and subsequently powdered and tested. The samplers rather ridiculed the idea when he began to test cement by the carbonate of lime method; but when he showed them his results twenty-four hours before they could obtain any results at all, they saw there was something in his method, and the calcimeter had now been adopted as the controlling apparatus for the whole of the cement industry. The rotary kiln was adopted owing to the enormous economy in fuel combined with economy of labour that resulted from its use. It was worked out in the first instance in the United States because labour was very dear in that country, and the Americans made very large quantities of cement, but it was really an English invention. Ransome put up the first rotary kiln in this country. He did not know where the author had obtained his information with regard to the cement used in the Thames Tunnel; but personally he was always under the impression that it was what was called Roman cement, *i.e.*, burnt argillaceous nodules of London clay. When visiting the tunnel many years ago he noticed that considerable leakage was taking place, which was put down to the decomposition of the Roman cement. An engineer who was with him said that if Portland cement had been used it would not have happened. As a matter of fact, Roman cement was not so good. The statement made by Mr. Davis that clay was dredged up from the bottom of the river was not the case. The mud in the Thames valley that was used for the purposes of cement had been deposited in mud flats, which formed the blue mud used in cement-making. If the mud was taken out of the bed of the river itself he believed that a considerable amount of sand would be found in it which would render it unfit for the purpose of cement-making. Dredgers were used because it was found that it was an economical process to dredge the mud up out of the clay-pits instead of having to take the water out and dig it by hand. The author had also made the very general statement that limestone was used in the United States for making cement. As a matter of fact, a great variety of materials was used in that country. Personally, he had examined at least half-a-dozen, and they were not all limestone; some of them were real chalk, like English chalk. The statement made that only marl was used in Germany was not correct either. There was a big district in Germany, in

the neighbourhood of Oppeln in Silesia, where marl was used, but the great factories in the north of Germany used clay and chalk just as the English makers did. The accuracy with which the manufacture was carried on, as explained by the author, was really marvellous compared with the old manufacture. Manufacturers now worked to within one-half per cent., whereas a 4 or 5 per cent. variation was quite usual in old days. Personally, he thought it was unnecessary to aerate cement at the present time; but in earlier days, when the main-drainage scheme of London was started, Mr. John Grant, the assistant engineer of the Board of Works, specified that all the cement should be aerated. The fineness then specified was something extremely coarse compared with what was now required in a standard article. There was no doubt whatever that the extremely fine grinding now adopted had given an enormous impetus to the use of cement. The finer cement could be ground, the more cement would be sold. Cement could now be used for a hundred purposes to every one to which it was put when it was first adopted. In the beginning it was a hydraulic mortar, and nobody would rely on it for the main bulk of the structure. Bazalgette, the constructor of the Embankment, looked upon the use of cement as a hazardous experiment; but nowadays piles and pit-props, and all sorts of things were being constructed with it. It was a matter of very considerable importance, because wood was getting scarce, and the use of concrete in that direction should be considerably extended.

Mr. S. G. Robinson said there was an excellent reason for the almost exclusive use of the wet process on the Thames and the Medway, because it was found that not only could hard materials be ground more cheaply by using the tube method, but the intimate mixture of the raw material was much more easily obtained when slurry was used than could be secured with a dry powder.

Mr. A. C. Davis, in reply to the Chairman's question, said that the chemistry or crystallisation of the setting of cement was a feature of the manufacture that was extremely obscure. During the past six months he had inspected many factories in the United States, and on asking an eminent expert what his opinion was on the crystallisation, technology, or chemistry of the setting of cement, he received the reply that it was a subject upon which he knew nothing. No one could give any information upon it. The setting of Portland cement was no more understood than the setting of plaster of Paris. It was known that there was a mixture of silicates, aluminates and lime, but what happened when water was added to those crystals and the cement set was at the present time purely a matter of conjecture. The statements he had made with regard to coal vessels carrying chalk from the Thames and Medway district to the northern cement-makers, to which Mr. Butler had referred, applied only to the original arrangements made by the manufacturers in the north. Mr. Butler was quite correct in stating that at the present time special barges carried the chalk from the south to the north. The wet process was more particularly adopted on the Thames and Medway on account of the flints which were contained in the chalk, and those flints could only be taken out by mixing the chalk and clay with an excess of water so that the flints were precipitated. He did not include the Belgian cement in his paper, because the bulk of the material produced in Belgium was termed a "natural" cement, which was produced by merely quarrying the raw materials and burning them as they were quarried. He joined issue with Mr. Waycott's statement that a material existed in Belgium which, when quarried, put into the kiln and burnt, would make either a Portland cement or a cement as satisfactory as any artificial process of mixing. His experience of the deposits in Tournai was that the materials varied considerably in the percentage of lime they contained. He went over one factory in Tournai recently in which the percentage of lime varied from 72 to 82 per cent. As he had pointed out in his paper, it was essential to keep the chemical combination of the raw materials perfectly accurate or within a half or one quarter per cent. of the necessary standard to produce a good cement. Any material which varied from 2 to 10 per cent. in calcium carbonate could not be relied upon to produce a thoroughly good cement, unless the raw materials were mixed together, and a standard of composition was obtained. He did not think it was a fact that a geological formation was available in Belgium which had a perfectly uniform composition. His experience of Belgium was that no such deposit existed. If Mr. Waycott could prove that such a deposit did exist, and that a material could be obtained in Belgium that remained constant up to one-half per cent. in its calcium carbonate value, that material would produce as good a Portland cement as any that could be made by artificial means; but he had investigated the Tournai district, and was not prepared to believe that such a deposit existed. Mr. Reid had commented on the statement made in the paper that limestone was chiefly used in America. As a matter of fact, in the centre of the industry, in the Lehigh Valley district, where the bulk of the cement in the States was produced, a hard limestone was employed in its manufacture; but in America, as in every other country, cement was made from various materials. There was no doubt that marl was used in Germany, but a number of other materials were also employed. The shortness of the time at his disposal prevented him from referring to the subject in greater detail. He was glad Mr. Reid agreed that the aeration of cement was hardly necessary under the scientific process of manufacture at present adopted, and it was interesting to hear how the science of the manufacture of the product

had improved during the past decade. Mr. Robinson had stated that a better mixture could be obtained by a wet process than by a dry, but personally he was doubtful on that point. He thought that no better mixture of the raw materials could be obtained than by mixing them when they were perfectly dry; and it would be seen in the near future whether Mr. Robinson's forecast, that the wet method would supersede the dry, was a true forecast or not. At any rate, it was impossible to get away from the fact that the better part of the cement made in Germany, and practically the whole of the cement made in the United States and Canada, was produced by the dry process.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Mr. Davis for his interesting paper, and the meeting terminated.

THE RUBBER INDUSTRY IN PORTUGUESE EAST AFRICA.

While the natural resources of the province of Mozambique are but slightly developed, rubber has been exploited commercially for over half a century, and the possibilities of its development into a great source of revenue have become probabilities during the last few months. From Lourenço Marques, at the extreme south, to Ibo, at the northern extremity of Portuguese East Africa, landolphia of various species grows in profusion. This plant is extensively exploited from Inhambane, Beira, Quelimane, Moma, Angoche, and Ibo, the last three through the town and island of Mozambique. South of the Zambezi the landolphia is a vine, sometimes of great length, and, when permitted, it attains the thickness of a man's arm. This vine, Landolphia Kirkii, according to the American Consul at Lourenço Marques, is considered rubber-bearing when it reaches half an inch in diameter, and is tapped by a series of long cuts. The flow is more abundant at the end of the rainy season, and, owing to the great difficulty of getting at the vines, whose habitat is naturally the forests, they are tapped but once a year, and then bled for all there is in them. This rapidly reduces the output of a forest, and, where supervision of the natives is impossible, the percentage of vines utterly destroyed yearly is very great. Where the rubber is collected by organised companies, steps are being taken to restock the depleted forests, which is not difficult. The landolphia grows well from a slip, and, before the rubber-gathering season opens, men are sent through the forests and plant two slips to every tree that has no vine at its roots. This method of saving a forest, however, only benefits permanent holders or the State, as it takes landolphia from five to ten years to reach a stage in which it is fit for tapping. Outside the territory covered by the Mozambique and Buzi companies, the collection of rubber, whether south or north of the Zambezi, is entirely in the hands of natives who collect and sell it to the Indians at the coast. At Inhambane the rubber seems to be collected with much care, and compares well with what is known as Beira rubber, except that it is not brought in in balls but in split lumps, the latex having been wound on a small stick, which is then cut out. North of the Zambezi, beginning at the Ligonha River, stretches the region whence comes what is known on the market as Mozambique rooty rubber. The best of this is that coming from the Matadane range, which lies between Moma and the Cocola River on the south, and Talalane and the Larde River on the north. Inferior qualities are gathered farther north, and their principal final exit is at Mozambique, the capital of the district. All Mozambique rooty rubber—and it must be remembered that the name applies only to rubber gathered north of the Zambezi—is marketed in a crude state, containing bark and rubber in almost equal quantities. This is due to the fact that the natives prefer to rip up the roots of the landolphia and beat out the latex contained in them. With a view to stopping this practice, the government established an export duty on root rubber. Owing to the fact that most rooty Mozambique rubber comes from unpacified regions, to which white people have not had access, little was known as to the species of landolphia prevalent in the district, and it was generally accepted that the species was the same as that worked by tapping south of the Zambezi. Recently, however, the American Consul succeeded in crossing the Matadane country, and much was learnt as to the rubber of the region which was not known before. In the first place, while the plant bearing the rubber is a landolphia, it is very different from the species known south of the Zambezi, and is essentially a root producer. The plant is not inevitably destroyed by pulling up the serviceable roots. The Matadane landolphia has an extensive root system, running near the surface, out of proportion to the plant itself. These roots send up shoots somewhat resembling the suckers of wild cherry. A small shoot about the size of a lead pencil often leads to a root two or three times as thick. The latex, which is rich in quantity and of very good quality, is found in the bark of the roots. The method of securing the rubber is crude, but it is the most sensible that could be applied by the natives under the circumstances. After ripping up a bundle of roots, the native beats off the bark, which is then put over a small fire and brought to a boil three times. The latex appears as a fine web through the bark. The mass of bark and rubber is taken out after each boiling and kneaded to separate the bark from the rubber. The final result is a small black ball, with a high percentage of bark particles still left in the rubber. In tearing up the rubber plant, the natives say that if only a small part of the root is left it soon springs up again. This is a most important point, as far as the ultimate wealth of the region is concerned, and evidence supports the statement, as several tests were made at villages where piles of rubber-plant refuse were seen before every hut, by sending out natives for fresh roots. The installation of

simple machinery for cleaning out the bark and eliminating the damaging boiling process will bring Matadane rubber into favour in the market. While no rubber from the Landolphia Kirkii was seen by the Consul, it must not be assumed, he states, that this species does not grow north of the Zambezi. A plant closely resembling it, but whose latex seemed a little weak, was noticed in profusion in the Matadane country, where the natives took little or no notice of it. There is little doubt, however, that this vine, or something very similar, is exploited as far north as Ibo. Besides the landolphia, an indigenous rubber-bearing tree, Mascarenhasia Elastica, has been discovered. It yields rubber of good quality, but it is difficult to tap on account of the fluted formation of the trunk; and, as it requires fifteen years to mature, it would be of little value as a plantation tree. The only plantation tree which has been largely exploited in the province of Mozambique is the ceara, of which over 10,000 exist, mostly in small plantations. Up to the end of 1909, these trees had proved a failure and were mostly abandoned; but the visit of an expert on rubber in March, 1910, has brought back confidence in the ceara tree, and preparations are under way for extensive and systematic planting. The ceara does well throughout a vast extent of the province, and reaches the tapping stage at the end of three years.

THE CHINESE LACQUER INDUSTRY.

The earliest record of lacquer is said to date from the Sung dynasty, although it probably existed long before that date, but in a more crude form. It was introduced into Japan in the third century from Korea, at the time of the conquest of that country. The seventeenth century marked great progress in the industry in Japan, and the gold lacquer became very popular, but from that time its popularity decreased, and the demand did not revive until the last few years. In China the manufacture of the lacquer ware, known to the Chinese as the "No. 1 Foochow lacquer," can hardly be called an art: it is rather a craft, the result of infinite labour and patience, since the laying on of the coat or colour requires no more skill than the simplest form of painting. The superiority of the No. 1 Foochow lacquer over all other forms is due to its durability and beauty; it takes more time to prepare (in some cases several years), and possesses a finish and depth of colour unlike any other products of the same nature. The extreme care taken to refine the pure lacquer, the number of coats given, and the great quantity of gold and silver leaf usually used in the last coat are the cause of this. Concerning the gold and silver leaf used, the former imparts to the lacquer a dull gold colour, in whose depth a fine gold powder may be discerned, and the latter gives a silver green effect. Sometimes a little colouring matter is added, but the result is supposed to be better without it. The lac, as is well known, is not a manufactured product, but the sap of the *Rhus Vernicifera*, or Ch'ishu of the Chinese. The tree is tapped at night during the summer season, and the lac sold to the consumer as a dried cake, or in a semi-fluid state. It is first placed in a rectangular pan, where it is continually stirred with a spatula for about two days, then pressed by twisting the lac through a sack made of fine grass cloth, and lined with a thick layer of cotton. The refined lac is put into the pan again for a day, and the same process is repeated. So prepared, the lac will answer for the first coats given to the articles, but for the final or colour coat the lac used undergoes this process four times. According to the American Vice-Consul at Foochow, the invention of the No. 1 lacquer is said to belong to the Shen-Shao-An family, in whose hands the manufacture still is. To this same family is also accredited the invention of silk lacquer. The term lacquer ware applies only to the thing which has undergone certain preparations before receiving several coats of lac. Ordinary woodwork covered with Ningpo varnish, or even with lac, is not included. The proper lacquer ware may be chiefly divided into two kinds, the ordinary and the silk. The ordinary lacquer is applicable to almost every kind of furniture and to ornamental articles for the houses, but is commonly applied to woodwork. Only very old wood, usually cedar, which will neither warp nor crack, is used for this purpose. Articles and ornaments of the most delicate carving are treated in this fashion. To prepare the woodwork, such as furniture, for lacquer, a lacquerer scrapes the wood one or two inches wide along any crack or joint or opening that may exist. It is then filled up with lac and two or three coats of linen cloth, which will not only cover the depth, but also serve to keep the parts together. After a fortnight or longer, when the lac on the linen is perfectly dry, the woodwork is covered with a thin coat of black lac, mixed with a little "ching-chu," a refined red clay. Ten days later a process of general polishing is applied to the article with fine pumice stone of various shapes and sizes. About every ten days a new thin coat of the lac mixture is put on. The article is always polished before receiving a new coat. After the ninth or tenth coat of this black lac mixture, the article is thoroughly polished so as to receive the colour coat. For the preparation of the final coat, a small portion of lacquer that has undergone the refining process four times is mixed by a pallet knife on a stone surface with the gold or gold and silver leaf. When thoroughly mixed, it is placed in the centre of a thin sheet of cotton paper. The paper is then rolled together, with the lacquer inside, the ends being twisted in opposite directions, until the lac oozes through. This is repeated three times. The silk lacquer is generally applied to small articles, either for practical use or for ornamental purposes, such as vases, card-cases, and images. The art is so far advanced, that images of almost every description can be made under this system with accuracy and clearness. The process commences by pasting a

coat of native printing paper, with rice glue mixed with ching-chu powder, on a well-modelled clay image, care being taken to cut the paper into proper sizes to suit the different parts when it is pasted, and to paste it so neatly that every wrinkle of the face, or fold of the material, should there be any, will remain clear cut. After the pasting the figure is thoroughly washed with this thin mixture, and left to dry for two or three days. On the top of the paper is then pasted the silk with a plaster of black lac and pulverised ching-chu, with still greater care as to the overlaps and folds than is required in the paper coating. Ten days later another coating of silk is added after the necessary polishing has been applied. For small articles only two coats of silk are necessary, but in the case of larger ones one or two more coats may be added. Before receiving the colour coat, the image is placed in water for such a length of time that the clay inside will dissolve and can be taken out through a hole left at the bottom of the figure for that purpose. After the removal of the clay the opening is sealed, and a fortnight later the hollow and exceedingly light article is ready to receive its decoration. On silk as well as on woodwork, the colour coat is applied but once. The lac, though black itself, can be made into almost every other colour existing, and of various shades, by mixing it with other ingredients. The most costly colours are those which contain the greatest quantity of gold dust, and the colours in most common use are bronze or ochre green of various shades, and purple or dark maroon gold. The term gold lacquer is easily misinterpreted to mean lacquer ware sprinkled with gold dust, or fragment of gold foil, or inlaid with gold thread, etc. In gold lacquer the gold or silver has been pulverised so fine that it appears no more as sprinkled dust, but its richness is blended with the other colouring matter and the refined lac, giving a lustrous and lovely tint of a uniform shade. A genuine No. 1 Foochow lacquer will stand any climate and any amount of washing, even with boiling water. In the common form of lacquer unrefined lac is used for the primary coating, and that for the colour coat has not been refined more than twice. Instead of ching-chu, which is comparatively expensive, the powder of broken bricks and tiles is freely used.

HOME INDUSTRIES.

Bad Yarn.—It is a feature of the present position of the Lancashire cotton trade that spinners who spin the better qualities of cotton—which does not necessarily mean the finer qualities—have felt the depression less than others. The present season's crop of American cotton is worse for spinning than usual, and it is said that many of the stocks that are now depressing the spinning trade are inferior to the normal production of the spinners who hold them. In the opinion of the *Cotton Factory Times*, the attempts to use such stocks are prejudicing the operative workers, and it seems that "numbers of instances can be found where the average earning of the weaving shed is less than it was when the uniform cost was 10 per cent. lower than it is to-day," although operatives in other sheds, where the quality of yarn is being maintained, are earning fair wages. The *Cotton Factory Times* hints that unless there is less of this inferior yarn, weavers will rebel against "the restraint of mill and joint rules which under normal conditions would be regarded as convenient and reasonable methods for adjusting disputes." It is deserving of note that many cotton operatives are emigrating. Bolton is a centre of both the spinning and the weaving trade, and it is said "as many as fifty per week of all descriptions of workers are leaving for Canada and other colonies." It cannot be lack of work that is inducing emigration, for one of the causes for the accumulation of yarn, and the consequent proposals for short time in the spinning industry, is the lack of weavers to work looms.

The Coal Mines Bill.—This Bill has been read in the House of Commons a second time after only two hours' debate, and notwithstanding the great complexity of the measure. That legislation is necessary for the better avoidance of accidents in mines is hardly open to doubt. From the beginning of mining statistics until five or six years ago, as was pointed out in these Notes recently, the percentage of fatal accidents amongst miners in Great Britain steadily fell; afterwards it was practically stationary for some years, but last year the total casualty list reached 1,620 lives, which is the largest number of deaths by accident since yearly statistics began. The total was of course greatly swollen by the disasters at Whitehaven, and Hulton Colliery, which had much to do with bringing home to Parliament the necessity for additional and more stringent regulations. The Bill now introduced by Mr. Churchill covers very wide ground, and it deals with the health and safety of upwards of a million persons, of whom 848,000 are employed underground. Most of the proposals are based on the recommendations of the Royal Commission, while others have been suggested by the mining experts of the Home Office, and others again by inquiries into the causes of the recent accidents. Everything except check-weighing and the eight-hour day is covered by the Bill, and the two exceptions have been dealt with in recent legislation. The provision making it compulsory for miners to wash may seem fantastic, but the main provisions of the Bill appear to be approved alike by the representatives of the owners and men. The Bill amends and consolidates the law relating to coal mines, including a certain number of enactments which will now be repealed, from the Coal Mines Regulation Act of 1887 down to the short Act for the better provision for rescue apparatus passed last year, and adds to the contents of these, while it consolidates a large number of fresh provisions for the prevention of danger, accident, and disease. Accidents in the shaft through over-

winding and breakages of rope, in the haulage way, through tubs leaving the track, or from falls, deaths from diseases, such as fibroid phthisis, induced in dusty atmospheres, are covered by the Bill. It also prohibits working in sections where the presence of gas rises above 2½ per cent.; the duties of foremen and deputies are more carefully safeguarded; provisions are laid down more stringently than ever as to safety-lamps; an attempt is made to grapple with the dust problem; and there are for the first time regulations for the provision of separate travelling roads in all new mines, and their construction in old ones where the authorities deem it necessary. Among the valuable provisions of the Bill are those for the erection of rescue stations and the right of search for matches. It may be regretted that the Bill contains no provision to prevent women pulling tubs or kans about pit banks, or for prohibiting the employment of girls on pit banks; the pit pony, too, is forgotten. It is also to be regretted that there has been no adequate debate on the Bill, either on introduction or second reading, but ample time is promised for deliberation in the subsequent stages. The Bill is not to come before the Grand Committee until after Easter, and in the interval there are to be conferences between the owners and the men, so that as far as possible the provisions of the Bill may take final shape as the result of mutual agreement.

Aid to Cotton Growing.—Early last year it was proposed that the operatives employed in cotton mills should make a contribution of one penny per month for a period of fifteen months to the funds of the British Cotton-Growing Association, for the purpose of helping in the completion of the capital of £500,000 required by the Association for the carrying out of the efforts to enlarge the area of our cotton supply. The annual report of the Amalgamated Association of Operative Cotton-Spinners just issued refers to the matter as follows:—"The proposal was made consequent upon an undertaking by the Employers' Federation to get their members to contribute an additional £72,000 to the cotton-growing funds. The penny per month was estimated to aggregate to about £30,000, which was considered to be a fair proportion to come from the operatives in addition to their previous subscriptions. In common with other operatives' associations, the proposal was taken up by our Amalgamation, and our members have willingly paid their quota when the collections have been taken. The amount realised from these monthly collections up to the present is short of £12,000. It is hoped the collections will be continued until the whole of the £30,000 is raised, whether it takes fifteen months or longer. As time goes on, the work being done by the British Cotton-Growing Association is shown to be more and more necessary, and the need for its further extension becomes increasingly apparent. Until the sources from which our cotton supply is drawn are numerous enough and extensive enough to enable the trade to cease to be almost entirely dependent upon any single country, as it is at present, we shall continue to have these periods of scarcity, with the attendant speculation and cornering which work so detrimentally to the interests of all engaged in the industrial departments of the trade."

The Potteries Dispute.—There is trouble among employers and employed in the Potteries. The operatives desire the abolition of the apprentice system, so far as it permits the apprenticeship of persons over twenty-one years of age. It is alleged that there are hundreds of the older men who are compelled practically to enter into private contracts with their employers to do piecework at a lower rate than standard. These men are, it is said, termed apprentices, and it has been known to happen that a young man has been working as a full journeyman while his father was an apprentice. Then the men are asking for the abolition of the "good-from-oven" rule, which requires that any article made by an operative shall be delivered in good condition to the employer, after it has been through the baking ovens, before the potter can be credited with it in his wages. The contention of the workmen is that if an article which is properly made is spoiled in the oven they shall still be paid for it. Beyond these proposals the men demand a general advance in wages. In the general earthenware trade they are asking for a 10 per cent. advance. The sanitary trade pressers, who had a 15 per cent. reduction two years ago, are asking for a 7½ per cent. advance. The teapot-makers want an advance of something like 25 per cent., claiming to justify it by changed conditions in their industry. The National Amalgamated Society of Male and Female Pottery Workers has about 4,500 members; the other two, the oven-men and kiln-men, and the packers, are understood to have only about 500 between them. Altogether the three unions have only about 5,000 members, and a rough calculation gives the number of operatives in the pottery district as something between fifty-five and fifty-eight thousand. The workers in the higher class of ware, who are half of the total number of operatives, are practically unaffected by the present dispute, but the processes of pottery manufacture are so highly specialised that they are largely dependent upon each other, so that a strike would concern not only those operatives who give in their notice, but many others who work alongside them.

A State Agricultural Bank.—Details as to the Government's scheme for a State Agricultural Bank are beginning to leak out. It is understood that a leading feature will be that the bank shall lend money to farmers at one half per cent. over Bank rate on condition of being allowed to audit the borrowers' accounts. But it is objected that this condition as to audit will prevent many farmers from applying for loans. Solvent men will not care to submit their affairs to State

inspection, and the much more numerous class of insolvents will know that application for assistance would be fruitless. Reference may be made in this connection to the experience of Belgium. In order to help the larger farmers, the Government in 1884 passed a law which led to the creation of a number of institutions known as *Comptoirs agricoles*, or agricultural banks. Each of these institutions consists of three, four, or five persons, who negotiate loans to farmers. They provide no capital themselves, but borrow all they require from the National Savings Bank, giving to that institution their personal guarantee for the repayment of the money, and receiving in return one-fifth of the interest charged to the borrower. At the end of 1907 there were eleven *Comptoirs agricoles*, with 2,755 loans actually running, the total amount of which came to £425,925. For very small farmers and peasant cultivators there are the Raffeisen banks. In 1907, 3,626 loans were granted, nearly one-half of them for sums less than £10. These loans are used for the purchase of cows, for the purchase, construction, or repair of houses, for trading capital, for setting young couples up in their homes, for the purchase of land, for the *paiement de soulte*, or the division of a property—that is to say, the sum payable in cash by any heir who has received more than his fair share of landed property on the division of an estate—for the purchase of a horse, for the repayment of debts contracted at usurious interest, and for various other objects. The regular rate of interest charged to borrowers is 4 per cent., while 3 per cent. is allowed on money left on deposit. The difference, less a small deduction for expenses of management, goes to a reserve fund. Although these banks have no capital, and although the reserve fund is not very great, there has never been a single case in Belgium of the failure of such a bank. With the growth of peasant proprietorship in this country the need for some such banks is becoming pressing.

GENERAL NOTES.

The Exhibition at Rome.—The exhibition at Rome, unlike most previous exhibitions in other places, is not confined to a restricted area, but extends from one extremity of the city to the other. It illustrates the three periods in the life of Rome, namely, ancient, Papal and modern times. The first section extends from the Capitol to the Appian Way, so that the visitor, after passing the Forum, the Coliseum, and other monuments of the past, reaches the Thermæ of Diocletian where the archæological exhibition is held. The history of Rome under the Popes and during the Renaissance periods is written everywhere; the churches, palaces, fountains, etc., all bear witness to the grandeur of that period which inspired such men as Michael Angelo to conceive such monuments as the cathedral of St. Peter's. The exhibition of Italian Art during the Middle Ages and Renaissance is held in the Castle St. Angelo, once palace, prison, and fortress; here the apartments of the Popes, as they were during the fifteenth and sixteenth centuries, are seen sumptuously furnished, with priceless furniture and collections of works of art. On the boundary of the modern city and extending beyond the Villa Borghese, and surrounded by the buildings constructed by the various nations who are taking part in the exhibition, is the beautiful gallery built to contain the works of living Italian painters and sculptors. This building is intended to remain afterwards as a permanent gallery of modern art. Crossing the Tiber by the fine new bridge, we reach the group of buildings in which are held the Artistic and Ethnological Exhibitions, and the Exhibition of Music and Dramatic Art. Reproductions of many of the most notable buildings in the various regions of Italy illustrate the different styles of architecture. Here the various dialects, folk-songs, etc., may be heard, and the characteristic dances of the country and the dresses and customs of the people observed. Festivals, competitions of every kind, and aviation meetings are being organised; whilst upwards of fifty congresses on a great variety of subjects will be held in a building specially constructed for the purpose near the Castle St. Angelo.

Cotton-growing in the West Indies.—It is disappointing to find that from various causes the cotton industry in the Leeward Islands received a check last year. In his report on the Blue Book of the Leeward Islands just issued, Mr. H. E. W. Grant, the Colonial Secretary, directs attention to this check, which he attributes partly to low prices and partly to bad weather and heat. Blister mite was very prevalent and adversely affected the crop, whilst the unwise habit of leaving old cotton bushes on the land greatly aggravates the evil. Fortunately the islands have hitherto escaped serious visitation from the cotton worm. In the Virgin Islands there remain large numbers of cotton plants of an inferior type, and the Government is doing what it can to persuade the planters not to use the local seed for planting but to import it. In Antigua the acreage under cotton has been decreased owing to losses sustained from the attacks of the "Flower-bud maggot," and in St. Kitts only 1,100 acres were planted owing probably to the fall in prices in the previous year. From Nevis and Montserrat the returns are more satisfactory, but the exports of cotton from the Leeward Islands are never likely to be large.

Stock Breeding in Siberia.—The most important industry in the Transbaikal Province is stock breeding. Cattle, horses, and sheep predominate, although a limited number of camels, deer, goats, and swine are bred. The horses average between twelve and thirteen hands high, and can draw a load of over one thousand pounds; and if driven in a troika (three horses harnessed abreast) they can cover thirty to forty miles a day. Journeys

of thousands of miles, at an average rate of forty miles a day, have been made by riding these animals. The horses are kept in the open throughout the year, and in winter they find their food under the snow. Some improvement has been made in breeding these horses, and only recently Arab blood was introduced. The cattle are of Mongolian origin, and are inferior and very small. They live in the same manner as the horses, and it is remarkable how they can withstand the severe climate and lack of food.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock :—

March 29.—George B. Heming, "Art Education in the Jewelry, Goldsmithing and Allied Trades." Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., will preside.

April 5.—Henry L. Heathcote, B.Sc., "Wheels, Ancient and Modern, and their Manufacture."

Indian Section.

Thursday afternoons, at 4.30 o'clock :—

April 27.—Sir Thomas Henry Holland, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India." Lord Avebury, D.C.L., LL.D., F.R.S., will preside.

May 25.—W. R. H. Merk, I.C.S., C.S.I., LL.D., "The N.W.F. Province of India."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock :—

April 4.—Captain R. Muirhead Collins, R.N., C.M.G., Official Secretary in Great Britain for the Commonwealth of Australia, "The Commonwealth of Australia." The Right Hon. Lord Denman, K.C.V.O., Governor-General Designate of Australia, will preside.

May 9.—F. Williams Taylor, "Canada and Canadian Banking."

Cantor Lectures.

Monday Evenings, at 8 o'clock :—

Professor J. A. Fleming, M.A., D.Sc., F.R.S., "Applications of Electric Heating." Four Lectures.

Syllabus.

Lecture IV.—March 27.—"The Domestic Applications of Electric Heating." Electric Water Heating—Its Cost and Economy—Air Heating by Electric Radiators and Convectors — Electric Cooking—Various Systems and Types of Utensil critically discussed—The Advantages and Drawbacks in Comparison with other Methods of Culinary Heating.

Alfred E. H. Tutton, M.A., D.Sc., F.R.S., "Rock Crystal : its Structure and Uses." Four Lectures.

May 1, 8, 15, 22.

Dates to be hereafter announced :—

Frank M. Andrews, "Architecture in America."

Professor Raoul Pictet, "Les Basses Températures."

Sir William Abney, K.C.B., D.C.L., D.Sc., F.R.S., "The Quantitative Measurement of Colour-Blindness."

Hal Williams, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

Noel Heaton, B.Sc., F.C.S., "The Production and Identification of Artificial Gems."

MEETINGS FOR THE ENSUING WEEK.

Monday, March 27...Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor J. A. Fleming, "Applications of Electric Heating." (Lecture IV.)

Geographical, Burlington-gardens, W., 8.30 p.m. Mr. H. J. Mackinder, "The New Geography: its Aims and Methods."

Actuaries, Staples Inn Hall, Holborn, W.C., 5 p.m. Mr. G. W. Richmond, "State Insurance against Invalidity and Old Age—the Actuarial Basis of the Austrian Method."

Tuesday, March 28...Association for Befriending Boys, at the Royal Society of Arts, John-street, Adelphi, W.C., 4 p.m. Annual General Meeting.

Cold Storage and Ice Association, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. M. Aurel Stein, "Explorations of Ancient Desert Sites in Central Asia." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Mr. Philip Dawson's paper "The Electrification of a Portion of the Suburban System of the London, Brighton and South Coast Railway." 2. Mr. J. W. Smith, "The Improvement of Highways to Meet Modern Conditions of Traffic." 3. Mr. H. P. Maybury, "Recent Development in Road-Traffic, Road-Construction and Mainten nce."

Photographic, 35, Russell-square, W.C., 8 p.m. Messrs. J. S. Dow and V. H. Mackinney, "Surface Brightness, its Measurement and its Application to Photography."

Wednesday, March 29...Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Mr. George B. Heming, "Art Education in the Jewelry, Goldsmithing, and Allied Trades."

United Service Institution, Whitehall, S.W., 3 p.m. Lieut.-General Sir R. S. S. Baden-Powell, "Boy Scouts."

Thursday, March 30...Antiquaries, Burlington House, W. 8.30 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. A. Bone, "Surface Combustion and its Industrial Applications." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. H. E. Corke, "100 English Wild Flowers, with Autochromes."

Friday, March 31...Society of Authors, at the Royal Society of Arts, John-street, Adelphi, W.C., 3.30 p.m.

Aeronautical, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Annual Meeting.

Royal Institution, Albemarle-street, W., 9 p.m. Professor H. S. Hele-Shaw, "Travelling at High Speeds on the Surface of the Earth and Above it."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. J. Swinburne, "The Uses of Chemistry in Engineering." (Lecture II.)

Saturday, April 1...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Radiant Energy and Matter." (Lecture V.)

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FRIDAY, MARCH 31, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

TUESDAY, APRIL 4th, 4.30 p.m. (Colonial Section.) Captain R. MUIRHEAD COLLINS, R.N., C.M.G., Official Secretary in Great Britain for the Commonwealth of Australia, "The Commonwealth of Australia." The Right Hon. Lord DENMAN, K.C.V.O., Governor-General Designate of Australia, will preside.

WEDNESDAY, APRIL 5th, 8 p.m. (Ordinary Meeting.) HENRY L. HEATHCOTE, B.Sc., "Wheels, Ancient and Modern, and their Manufacture." The Hon. RICHARD CLERE PARSONS, M.A., Vice-President of the Society, will preside.

CANTOR LECTURE.

On Monday Evening, March 27th, Professor J. A. FLEMING, M.A., D.Sc., F.R.S., delivered the fourth and final lecture of his course on "Applications of Electric Heating."

On the motion of the Chairman, a vote of thanks was accorded to Professor Fleming for his interesting course.

The lectures will be published in the *Journal* during the summer recess.

CONVERSAZIONE.

The Society's Conversazione will be held this year at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday, May 30th, from 9 p.m. to 12.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

SIXTEENTH ORDINARY MEETING.

Wednesday, March 29th, 1911; Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., LL.D., M.D., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society :—

Browell, Colonel Edward Thomas (late R.A.), Merrow House, near Guildford, Surrey.

Cotman, Henry William, The Quadrant, St. Ives, Hunts, and the Arts Club, 40, Dover-street, W.

Evans, J. Howell, M.A., M.B., M.Ch. (Oxon.), F.R.C.S., 25, Berkeley-square, W.

Graham, W. L., 33, Bowerdean-street, Fulham, S.W., and Bon Accord Sheet Metal Works, Townmead-road, Fulham, S.W.

Hudson, Lieut.-Colonel Sir William Brereton, K.C.I.E., Fairholme, West Kensington, W.

Khan, Khur Shaid Ali, c/o Messrs. Henry Adams and Son, 60, Queen Victoria-street, E.C.

Provis, Charles Herbert, Highfield, Mutley-road, Plymouth.

The following candidates were balloted for and duly elected members of the Society :—

Eccles, Ernest Edward, M.I.E.E., Foyers, Lochness, Scotland.

Rahder, Christiaan Lydius, LL.D., Sourabaya, Java, Netherlands East Indies.

Ritchie, W. W., District Postmaster, Chengtu, West China.

Sang, Alfred, 96 Boulevard de Versailles, St. Cloud, Seine-et-Oise, France.

Stewart, Professor Louis Beaufort, University of Toronto, Toronto, Canada.

The CHAIRMAN said that in the Book of Nehemiah iii., 8, it was recorded that among those who volunteered to assist the Prophet in the restoration of the walls of Jerusalem were Uzziel of the Goldsmiths' Guild, and Hananiah of the Apothecaries' Association; and this fact, recalled to mind by him when receiving the invitation to take the chair there that evening, was the determining cause of his accepting it, quite unworthy as he felt he was to preside over a meeting of the Royal Society of Arts on so important an occasion. He had argued that as the goldsmiths' art and the

art of the apothecary were the oldest arts in the world, and among the earliest named in the oldest Sacred Books of the human race, there was after all, something of propriety, if only of a whimsical sort, in his sitting in the chair on the evening Mr. Heming stood at the reading-desk. But the predetermining cause of his so doing was his deep interest in the subject of Mr. Heming's paper, and his keen appreciation of Mr. Heming's work in artistic plate and jewelry; and furthermore of his patriotic and successful labours, so sympathetically and laudably recognised by the Goldsmiths' Company, in organising, within and by the trade itself, a system of sound and thorough-going education alike in the artistry and the technique of their deviceful and exquisite, and noble and famous, and most ancient art. The recognised successor of the late Robert Philips of Cockspur-street, as an exponent of the traditionary styles of English goldsmithing and jewelry, Mr. G. B. Heming needed no introduction to the members of the Royal Society of Arts, but in consideration of the subject of his paper, he (the Chairman) desired at once to emphasise how apt an illustration Mr. Heming was in himself of the immeasurable value of heredity in the maintenance of high excellencies in the practice of artistic industries, or the applied arts generally, and especially of the sumptuary arts.

To begin with, his very name bewrayed him a Dane, and of a family the Hundred Rolls showed to have already by the thirteenth century become established in Yorkshire, Lincolnshire, Norfolk, Cambridgeshire, Northamptonshire, Suffolk, and Essex. The Wars of the Roses broke up the continuity of family life throughout England; but some of these families recovered their position, and resumed their historical continuity in the Parish Registries, under the Tudors; from which date the name of Heming became familiar in London from Bethnal Green way and Highgate to Charing Cross.

Thomas Heming, Goldsmith to George II. and George III., was well known to every lover of English plate for his fine silverwork, bearing dates from 1745 to 1780; and from him his business has descended, from father to son, to the lecturer of that evening. This heredity was the secret of the Hindu's excellency in the industrial arts; and when you praised a Hindu goldsmith, or wood or stone carver, or weaver, or potter for his work, he would reply that he was but handing down the ever-accumulating merit of his forefathers—through nearly 3,000 years past—to his children, and children's children; and he prayed it might so accumulate through them for yet 3,000 years to come. Such facts should not be overlooked when considering the pressing problem of technical education in every department of industrial activity and enterprise throughout the United Kingdom. He had stood too long between Mr. Heming and his audience, and without further parley would now ask Mr. Heming kindly to proceed with his paper.

The paper read was—

ART EDUCATION IN THE JEWELRY, GOLDSMITHING, AND ALLIED TRADES.

By George B. Heming.

The statement has often been made, and is constantly repeated, that the English are an inartistic nation. If, for the sake of argument, we admit this rather sweeping assertion, it is obvious that the duty of protecting and encouraging good art is incumbent upon us all; but if we were the most artistically-minded people on the face of the earth, it would none the less be our duty to defend our art from the morbid tendencies, the careless design, the crude execution, the purposeless and unmeaning absurdities which can so easily undermine the beauty and mar the expression of works of art, whether they find their theme in music, in painting, sculpture, or architecture. In this paper, however, which it is my privilege to read before a Society that has consistently been on the side of good art, my remarks must be confined to art in its relation to those trades that have always prided themselves upon the production of beautiful objects.

Trades like those of the goldsmith and the silversmith demand, on the part of the persons engaged in them, a certain knowledge of drawing and modelling, in addition to dexterity in the manipulation of the materials in which they work. The introduction of machinery has increased the production of gold and silver articles, but it has naturally affected the position of the working goldsmiths and silversmiths, and in many cases their crafts have disappeared, or have become subdivided into many branches, and come at last to be considered as separate trades. In that fine old Anglo-Saxon word, "craft," meaning grasp, power, ability, particularly skill or cunning in artistry of hand, we touch the crucial point of our subject. With the advent of the machine we almost bid farewell to the craftsman—the man who fashioned a thing carefully and lovingly with his own hands from beginning to end, who put into it—who, indeed, could not help putting into it—something of his own personality, and who gave it a unity of adornment both simple and natural. "Fine art," said Ruskin, "must always be produced by the subtlest of all machines, which is the human hand; no machine yet contrived will ever equal the delicate machinery of the human fingers." "Time was," wrote William Morris, "when everyone that made anything

made a work of art besides a useful piece of goods, and it gave him pleasure to do it." Under the present conditions, each item is machined out in facsimile of its predecessor, and the pleasure of the workman only comes with the daily closing hour and his pay-day at the end of the week. How can such methods result in anything but the deterioration of artistic work of any kind, and the degradation of the artistic workman? In olden times, what was sought in any craft was that each article produced should possess two qualities—first, a design combining suitability to the purpose the article was intended to subserve with elegance of proportion; secondly, soundness of construction. From this standard the demon of the machine pulled us down, and things were probably at their worst about the middle of the nineteenth century, when all the decorative art of this country reached an unprecedented state of decadence and disrepute. It was Ruskin who first preached the gospel that our daily work should be more than a mere struggle for our daily bread. "Whatever you are to make your bread by," he wrote, "so far as you have time and power, make yourself first a noble and accomplished artist, and understand at least what noble and accomplished art is; you will then be able to apply your knowledge to any service." To us, living under an economic stress even greater than was the case when Ruskin wrote those words, such utterances may sound to some present as those of a voice crying in the wilderness; but I will venture to say that, despite the economic and social problems which we have to confront—the problem of producing quantity without a dead level of sameness, and often of unutterable ugliness—the antagonism between art and the machine is not irreconcilable, nor so hopeless as it appears, and that the day of the revival of the British craftsman is not far distant, and, indeed, is near at hand.

Bearing on this question, I will condense a few admirable remarks from an address delivered by Mr. Luther Hooper on Handicraft at Haslemere:—

"Handicraft is not the mere skill of hand acquired by constantly practising one particular movement or set of movements; in fact, the same uniform and uninteresting qualities which we deprecate in machine-work might be produced by hand, when by mechanical practice and repetition the hand had been degraded to the level of a machine. Work deserving the name of handicraft must be produced by the skilful hand under *the direct control of the thinking power of the worker*—under the direct control of his brain; and the excellence of his work would depend on the artistic power and judgment brought to bear upon it." He believed in the use of machines and labour-saving appliances, provided that the work done by their means could not be better done by hand; but we must see that the machine-made article is as good for utilitarian purpose as the hand-made one. "Up to a certain point the machine was a good, useful, and economical servant, but its perfection was a dead level of uniformity, unpleasing and dull, and its imitations of ornamental or other art were vulgar and pretentious failures—in short, it could not give that impress of thought and mind to its work which renders the simplest specimen of true handicraft more or less satisfactory and interesting. The advantage of handicraft was that it imparted a personal quality to all work produced, and it was that expression of the artist's self which made it interesting."

For the last twenty-five years we have been placidly watching the advance of our French and German competitors in all industrial and commercial matters, forgetful of its true significance and of the national interests at stake. Germany's stupendous economic success is largely due to her national system of specialised education, and her State support of scientific, learned, artistic, and economic activities in every part of the Empire. France also, progressing by fits and starts, but with a vivacity that compensates for the more stolid advance of the Teuton, is in many ways artistically far ahead of us, doubtless aided by the Latin temperament of her people. It behoves us to awake from our lethargy of self-complacence, and to move at least abreast with France and Germany. If our jewelry trade, and the trades dealing with the precious metals—of which, you will bear in mind, I am particularly speaking—are to be maintained against the inroads of foreign competition, and saved from obliteration, we must not lose a moment in our endeavour to improve the technical and artistic education of the young "apprentice" and "improver" in these trades, encouraging him by every means in our power, and, if necessary, founding travelling scholarships to enable him to broaden his knowledge and enlarge his ideas by visits to France, Italy, and Germany. As a people, we desire—or ought to desire—not only material prosperity; we look forward beyond that to a future of the highest artistic achievement; and I see no reason why the two ends we would set before us should be regarded as incompatible. The attainment of these ends should at least be particularly dear to us all. We undoubtedly possess many of the essentials of success in such a competition. Why, then, should our ambitions be low? A trade such

as ours—which, it must be remembered, offers exceptional opportunities for the expression of artistic values, and has attracted by its possibilities many eminent artist-designers and workers of exquisite ability and manipulative cunning, whose names are familiar to you—should be always boldly progressive and sagaciously self-confident in its attempt to raise its standard. That our neighbours across the Channel have realised this is one of the secrets of their splendid successes in jewelry and goldsmithing. A charge is often brought against us that we produce no great artists, but my belief is that we have as many artists in our trade as the French, but unappreciated, unregarded, and, therefore, undiscovered. I wish, however, not to deal in vague generalities; my idea is to treat this subject as far as possible from a practical point of view, with the endeavour to create the artist-craftsman, as contrasted with the idealist, whose art I fully appreciate, but who, for the present, at any rate, aims too high for this commercial age. For it must be borne in mind that we are faced with two considerations—one the demand for artistic ornament, the other the gratification of vanity; and in some instances, of course, the cost of the materials employed introduces a third. For years we have been content to import our designs; we have grown so accustomed to this free trade in art that we have overlooked our own native designers and the possibility of their higher education. Happily, there are not wanting indications of a much more hopeful state of things in the next few years, although we have a difficult task before us.

Before proceeding to describe what is being done here in London towards the solution of the difficulty, and to suggest what may yet be done for the education of the practical apprentice, I may, perhaps, with advantage outline some of the methods that are being pursued abroad for the training of the art student in jewelry, goldsmithing, and kindred work; and you will observe that not only is he trained, but he is encouraged in every imaginable way to excel. The School of Industrial Arts, Geneva, founded in 1876, administered by the city and the Swiss Government, will provide us with an object-lesson. The aim of this school is to qualify boys and girls for positions in all artistic crafts and trades; pupils are admitted at the age of fifteen, and are taken through a course extending over four or five years, according to the particular calling for which they are preparing. The school for teaching decorative art directs especial attention to theoretical work; the school of industrial art devotes itself exclusively to the practical side, but does not allow pupils to neglect those studies in design, modelling, and composition which are indispensable for the successful practical pursuit of any artistic craft. If an aptitude for the fine arts is shown, it is encouraged, and a pupil of talent will be assisted in his living expenses, so that he shall not be hindered on the road to success by extraneous worries. The students are practically apprentices, paying *no* premium, receiving *no* remuneration, and turning out excellent work under the direction of experts. All materials—such as marble, silver, gold—are supplied free; the articles produced become the property of the school, and their sale is a source of revenue. The conditions differ entirely from those which obtain in our English schools of art. There is no preponderance of immature learners acting as a drag on the class-work, no attendance merely to pass the time; the single endeavour is to teach and to learn some art-trade in the most perfect manner. Complete and saleable work is insisted upon in every department; nothing sketchy or unfinished is allowed to pass; every trained student can command his price in the market, and on leaving the school can immediately earn a fair salary.

This school cost the city of Geneva £40,000 for building and equipment, and the expense of maintenance is £5,000 per annum, half of which is provided by the State and half by the city; it is free to all, even to students from foreign countries. The principle of free education has long prevailed in Geneva, and has contributed largely to the industrial prosperity of the Swiss Republic. In order to qualify for entry, a pupil must have passed the primary schools. When he has selected a craft—enamelling, for example—he must study several subjects which will bear upon it from an artistic point of view. Thus, at the finish of his time, he is something more than an enameller; he is an artist, and is looked upon by employers as infinitely better than one who has been merely apprenticed in a workshop. Diplomas and certificates of capacity are given to students who pass the necessary tests.

Thus is Switzerland, one of the smallest of nations, holding its own through the turmoil in which art is at present involved, asserting its tastes, expressing its individuality, setting a great and salutary example to Europe, giving new life to art and a new tone to that life throughout the world. When the work of the individual

citizen is so important, each person so thoroughly trained helps in the general progression of the world, and adds his stone to the immortal monument of history.

In Paris, again, systematic training of the young, on sound methods, was adopted more than thirty years ago as a feature of the artistic trades. The goldsmiths and silversmiths there regarded education as an urgent personal matter, and started schools with a common view of raising the standard of work and the status of the workman; the latter, as a rule, naturally being a corollary of the former. They had a membership list of 700, divided into sections, for their different work. The members went to the classes to see that the boys studied in a right spirit. During a stay in Paris, in 1908, I visited some of the schools, and found fifty or sixty boys in each class, all of them earnest and keen to learn their business. They were taken at intervals, in small companies of three or four, to examine the works of art in the museums, under the supervision of the committee. Having witnessed how any sign of artistic ability is encouraged in the French boy, I cannot help comparing him with the type of English youngsters whom one frequently sees in our various museums, wandering aimlessly through the different galleries, taking no interest whatever in the beautiful objects that surround them. In the French provincial townships, also, schools of commerce and industry have been in existence since 1892, organised for the instruction of workmen who have to take their places in various departments of trade, and assisted by the State. The committees which advise the schools are almost exclusively composed of manufacturers and traders, and, as a consequence, the students are supervised by men who are exceptionally qualified to see that the instruction is of such a nature as to have a practical and beneficial bearing upon the particular industries of the locality. The French Society for the Encouragement of Goldsmiths' Work—gem-work and the designing of personal ornament—originated in 1865, when a Monsieur Baugrand offered a sum of 500 francs as an award to the apprentice who should be adjudged most meritorious both on account of work and conduct. In 1874 another patriotic Frenchman set apart sufficient capital to enable a certain sum to be devoted annually to the encouragement of the best qualities in the *personnel* of this branch of industry; the result was the formation of a permanent society with the title I have mentioned. An interesting side-light is thrown upon the secondary but very important question of how careful training may improve character and manners. "The members of our trade," said a former president of this Society of Goldsmiths, "should clearly understand that our interests lie in the good conduct of our workshops as much as in the perfection of the work which is sent out from them. For this reason we should encourage our workmen to set a good example to the young people under them; we should seek to develop in our apprentices, character, desire for professional knowledge, and general aptitude for their work. The pursuit of such aims will certainly be of benefit to us all." Two kinds of prizes are given—one for excellence of work, the other as a recognition of moral qualities. This may come as a surprise to those who share the popular idea of France as a decadent nation. Awards are instituted for artists and manufacturers who, by their creative genius, or by their distinction in the teaching of their work-people, have assisted the progress of the industry; competitions, with additional prizes, are held for designers; and since 1887 a medal has been offered annually to the Guild of Engravers for workers in all kinds of metals. In 1890 an annual travelling scholarship of the value of 400 francs was founded, with the object of assisting employees to improve their position by the study of foreign languages, and of affording skilled craftsmen an opportunity of investigating processes of manufacture in other countries. Details of many other competitions, arising naturally and easily from the main original scheme, I need not give here; enough to say that from such nurseries of art and industry it is no wonder if a breed of skilled workmen and conscientious artisans is arising which must of necessity add to the wealth and prosperity of the respective countries; nor is it a matter for surprise that at the present moment, in the higher branches of jewelry, the foreigner monopolises 60 per cent. of our workshops—is better both in design and execution than our own home people, and more often than not displaces the Englishman when especially clever and fine work is in view, and this, in spite of the fact that a good English workman is second to none—save on the artistic side—in practical work.

All this energy, all this admirably systematised teaching, all this careful "education" of the boy—the possible artist—in the work which he prefers, whatever it be, tends, you will perceive, to the rehabilitation of the craftsman; and the question is probably already

uppermost in your minds: What are we doing in England, in the face of so discriminating a treatment of the problem in countries which the average Briton is too prone to look upon with a genial contempt? What are we doing here—in England? It is certain that there were periods in which the English goldsmith and silversmith showed great originality and taste, and in the olden times he occasionally produced a really great work of art. London, in the twelfth and thirteenth centuries, had its many guilds, that of the goldsmiths among others; but the City guilds suffered a serious eclipse during many centuries as far as the fostering of fine achievement in their respective trades was concerned; and what I wish is that they would now take up a similar work to that accomplished by the trades and municipal bodies in France and Switzerland, which I have already mentioned, so that our British work in designing and creating objects of applied art should not lag behind that of other countries. This question was partly dealt with, with a note of hope, in the *Journal* of your Society for last September, in an unsigned article, from which I will quote a paragraph:—

"Some designers would tell us that there is no longer a living to be made out of design. Some manufacturers would say, with equal sincerity, that there is no employing a student who has been educated at a school of art; they find they must train their men themselves. Whatever the cause, there seems no doubt that at the present time comparatively little attention is being paid by the schools to design for manufacture. Until some years ago the artistic crafts had been neglected; now, they are not only considered, but they take the first place. It is a pity, not, indeed, that students should design for the crafts, but that a greater number of both teachers and taught do not realise how necessary it is that design for manufacture should be our first consideration. It is wrong to ignore the artistic possibilities of the more ordinary objects. It would surely be a higher aim to try to make manufacture artistic, as far as may be, than it is to turn one's back on it or stand aloof in proud superiority."

That last sentence embodies the scheme on which I wish to engage your attention during the remaining portion of my paper, and as briefly as possible I will set before you what has already been done in the matter as far as our own city is concerned.

It was considered desirable to invite the co-operation of the leading members of our trade with the workers, in order to obtain opinions and experiences relating to the problems we had to face, and almost exactly three years ago, on March 10th, 1908, a meeting of manufacturing goldsmiths, jewelers, and silversmiths was held at Goldsmiths' Hall. Its object was outlined in the notice which we issued, from which I quote:—"To discuss the system of technical education as now applied to our trades, and to consider a scheme for imparting the necessary knowledge of drawing and designing to our apprentices and improvers, in view of the ever-growing demand by the public for more artistic goods, and the Continental competition to supply the same. The necessary instruction, it is felt, can only be successful by making *compulsory* the attendance of youths in their masters' time, and by recognising this as part and parcel of their daily work." The proposal submitted by the conveners of this meeting was to the effect that the classes suggested should be held from 5 to 7 p.m., at the present City and West-End technical schools, once or twice a week, for drawing and designing in all its branches, under efficient masters, thus enabling the manufacturers in our trades to make compulsory the attendance of their respective "apprentices" and "improvers." My use of the word "compulsory" must not be misunderstood; by it I do not of course mean that boys and young men should be forced to do this work against their will, or that individual liberty should be interfered with, but that such training should be, as I have just said, a part and parcel of the daily duties. At this meeting a preliminary committee was formed, which delivered its report and expounded its suggestions at a second meeting held on May 28th following. It decided that a society should be constituted combining the whole of the allied trades, wholesale and retail, with the title of "The Goldsmiths', Silversmiths', and Jewellers' Art Council," its objects being, firstly, to advance the practical and historical knowledge of art and design, as applied to these industries; secondly, to promote and carry out any kindred object for the well-being and advancement of the trade in general. The suggested course of action was eminently practical; it included classes, confined entirely to members of the trade, to be held at the Northampton Institute and the Central School of Arts and Crafts on four days a week, Mondays, Tuesdays, Wednesdays, and Thursdays, from 5 to 7 p.m., so that youths could attend on whichever evening might be most convenient to their employers. At these classes instruction should be given in freehand drawing, geometry, modelling, drawing from the antique, the cast,

plants, and still life, with short lectures on the history and development of art; finally, designing and painting should enter into the curriculum, in addition to the ordinary course of technical education and practical work in the evening classes. The committee considered that the system of technical education up to that time prevailing was not a success; boys were expected to re-learn work that should have become familiar in their own workshops, and were also given work beyond their capabilities; the study of art and its history was non-existent. It was recommended that the executive committee to be elected should be allowed the privilege of assisting the authorities in the proper directing of these classes, and also in the selection of suitable teachers.

With that second meeting, the indifference that had fallen on our trade began to be shaken off; those who had never given the subject an hour's thought fell into line, and realised that the education of future generations depends upon the energy of the present—realised, too, that this scheme held remarkable possibilities, apart from mere accuracy and improvement of handiwork—that it would encourage a spirit of ambition in the younger members, and a determination to make their way in the world. From this meeting, at which Lord Henry Bentinck, Dr. Mullineux Walmsley, and many other gentlemen spoke in support of our scheme, we date the formation of our Art Council. On June 25th a deputation was received by the Education Committee of the London County Council, and discussed the various questions involved, such as, for instance, the augmentation of the already existent evening classes, the attendance of learners during business hours, the formation of an Advisory Committee to assist in the management of the schools, and more especially in the selection of teachers, and so forth. By the end of that year, 1908, we were in fair working order; "The Goldsmiths', Silversmiths', and Jewellers' Art Council" was beginning to be felt as an influence, and there was some prospect, if things went well, of ultimately displacing the slipshod methods which were a disgrace to any nation priding itself upon the slightest acquaintance with the meaning of the word "artistic," and of setting in their stead a thoroughly organised system of training, which in the course of time should bear a rich harvest.

Meanwhile, pending the conclusion of the negotiations, we were eager to make a start on the good work. It will be remembered that the year 1908 was the year of the Franco-British Exhibition, with its wonderful display of modern French jewelry and goldsmithing—a display which roused the deepest interest in the minds of all who saw it, whether they regarded it merely as an exhibition of beautiful work, arranged to give pleasure to the eye of the beholder, or as something more significant. The Worshipful Company of Goldsmiths generously placed at our disposal funds with which to purchase five hundred tickets of admission for craftsmen in the trade, and to contribute to the travelling expenses of the holders, in order that they might study the collections in the Palaces of Applied Art and other buildings similarly useful. In this connection, I offered prizes for essays, by workmen over and under twenty-one years of age, on "The Benefit of Art Education as Applied to the Goldsmiths', Silversmiths', and Jewellers' Industries, and as Exemplified by the Exhibit of Plate and Jewelry at the Franco-British Exhibition." A considerable number of excellent essays were sent in, and the prizes were distributed at Goldsmiths' Hall on December 8th. I may digress here for a moment to quote from the admirable address delivered by Mr. Henry Wilson, at the Royal College of Art, on that occasion. After referring to the time when the English goldsmith was famed throughout the Continent, and when his handiwork and services were sought for as are those of France to-day, Mr. Wilson proceeded:—

"The technical skill and artistry of the Anglo-Saxon jeweler were only equalled, hardly surpassed, by the finest works of the Greeks and Etruscans, while Celtic work, or the gold-work of Ireland, which some suppose to have been produced by British refugees, has never been surpassed. Where are they now? The best English jewelry is produced either in Paris or by foreign workmen in England, which is as much as to say that the Parisian gibe, 'There is no English jewelry,' is true. I was discussing the matter of English goldsmiths' design with a very great Continental artist, who said:—'You have the fox which isn't like a fox, the horse-shoe and the riding-whip and the hunting-cap, the knot and the bow of ribbon, and the crescent, and you don't seem to be able to think of anything else. Your wildest flight of fancy never goes beyond festoons, or wreaths, or a menagerie of diamond animals.' Of course I did not like this. I knew it was so true. Yet how are we to avoid it? How are we to emulate the artistic achievements of the Continent and regain our lost artistic eminence? There are some who say:—'By educating our young workmen in the same way as those of France and Germany are educated.' We are assured that if we adopt similar methods, we shall have similar results. I think not. All

the foreign methods in the world would never make an English boy anything but English. It is not the method which makes the man, but the man the method. French and German methods are right because they are the outcome and the development of the respective needs of those countries. What saves others will not save us, for no two individuals are exactly alike."

To avoid any possibility of misunderstanding, I may perhaps mention that it is no part of our programme to adopt slavishly Continental methods, or to impose designs of foreign origin, beautiful though they may be, upon the attention of the English pupils; to direct them, rather, to consider wherein beauty consists, and to encourage their individual expression of it, is our hope, and the aim from which we endeavour not to diverge. These classes, then, are at the present moment in working order; that they are needed is evident from the fact that, at the census of 1901, the number of persons stated to be following the occupation of goldsmith, silversmith, and jeweller in the County of London was 7,390, of whom 657 were employers. The course of instruction which *we* should like pursued in the classes I may here outline roughly. In the first year, simple designs of lines, plain surfaces, round objects; designs after embossed work and plaster casts; plain use of the brush in wash-drawing. Second year: geometrical designs, perspective, drawings of ornamental plants, and ideas taken from the styles of the Middle Ages and the Renaissance of the seventeenth and eighteenth centuries. Third year: compositions after the antique and modern styles; embossed work, modelling, compositions after Nature, and the conventional treatment of flowers. Fourth year: designs and compositions after various periods, and the gradual composition of ornamental designs suitable for the needs of the crafts. Fifth year: advanced modelling, studies from life, thorough studies of the different styles; visits to the museums, with discussions and studies of classic and modern goldsmiths' work. Each and all of these studies can be modified to suit particular students, and blackboard lessons, lectures on the principles of design and on historic design should be a part of the method for advanced students. The whole scheme, in fact, while keeping strictly to its primary aims, is not rigid; it is flexible enough to allow for individual tastes and peculiarities, for only by such judicious flexibility, I am convinced, can the finest results be obtained.

"Trade without trade education," said Mr. Henry Wilson, in his draft report on one of our new schools, "is one, if not the chief, cause of unemployment. . . . No trade is justified unless it lift the worker and widen his horizon, unless it educate him. . . . You cannot expect beauty in the workshop if there be none in the school. You cannot produce fine work with faulty tools, nor good workmen from damaged material. . . . The connection between manual skill and intellectual ability is invariable. This means that for the majority of mankind the workshop is the best of schools, and that the best school is that most resembling the workshop, and that each system is at its highest when it is the means of the completed culture of the greatest number. It is not the amount of knowledge, but the quality of culture which counts."

These concluding words, which I should like to impress upon all who have to do with the training of the young, bring to my mind an accessory subject which appeals to me very strongly—the pitiable lack of ordinary education in the vast majority of those who apply for positions in our shops or workshops to-day. The boy looks smart, perhaps, but he does not know enough of the rudiments of politeness to remove his cap when he enters the sanctum of his prospective employer. The man seems promising, but he cannot write a decent letter, and his spelling of simple words would move one to laughter, were it not so pathetic in its significance of his limited outlook and cramped brain. I have in my own experience encountered numbers of such boys and men, and doubtless every person in this audience who has had occasion to employ labour can reinforce my complaint. Last December the London County Council took a step that may lead to encouraging results in this respect; it decided to establish, as part of its elementary school system, a series of higher schools to be termed "Central Schools," which should aim to give their pupils a definite bias towards some kind of industrial or commercial career; these pupils will enter at about the age of eleven or twelve years. At that age the character is not fully or rigidly formed; the receptivity of the brain and mind is not yet declining, and there is some hope that the combination of an industrial tendency with the normal process of education may make for the inculcation of manners, of a proper respect for seniors, and of a behaviour which shall be decent and dignified and orderly without being stiff or smug, or merely "put on" for the occasion. In this, I maintain, our schools

are doing a beneficial work. Unless he conforms to the discipline required of him, the learner finds himself at a standstill; but, as a matter of fact, he generally does so conform, and there is no reason to suspect that he finds it irksome. He enters into a new world—the world of art; and, as art progresses, life should become more beautiful. Our schools, in addition to cultivating this taste for beauty, and diffusing sound knowledge of its rules, are turning out highly competent workmen who are now in the trade. We are working, as it were, with saplings, which we trust will gather strength from the roots we so recently planted, and we look forward to see the mature, giant oaks which shall give strength and unity to the steady progress of art in objects of both use and ornament. "Inform a pupil's mind," said Ruskin, "refine his habits, and you reform and refine his designs." The epigram might almost be reversed — refine his designs, cause him to look on beautiful things, and you refine his mind.

In concluding, I must touch briefly upon the question of the teacher and his methods. Drawing, of course, is the basis from which the edifice is to be reared; art training should begin with the first lesson in drawing. It is a fact that often the first efforts of young pupils are better than the first attempts of those who begin later; they are less self-conscious, less contaminated by the influences of surrounding ugliness. To postpone the development of this power of expression is to cause it to wither; but the utmost care is necessary in the teacher. In fact, we may say that the more elementary the student, the higher the skill required in those who are to direct the first faltering steps. The teacher should not make too much of his own individual ideas; he must remember that his duty is not to force the pupil into his own already formed mould, into his own fixed style of work, but to find out that pupil's possibilities, and to encourage any efforts after originality, however tentative they may at first glance seem. It is the expression of the artist's self in a work that gives it interest, and training must be directed toward that end. I believe, with Mr. Catterson-Smith, that while the advantages of teaching simple drawing are obvious, there is a grave danger in the present system of what is called "teaching design." His experience was that children commonly possess an inherent *gift* of designing in much finer form than the ability to design can be acquired by teaching, and he suggested that drawing from Nature should take the place of the copying of stereotyped designs, which tends to damp down any originality in design with which the learner may be naturally endowed. If instruction in drawing were organised in our elementary schools on a large scale and on a serious footing, every child could be judged as to his or her fitness for further artistic education previously to entering any trade wherein art dominates the output; in fact, such training would often be a most useful factor in determining the child's true vocation. This additional teaching of drawing is quite in harmony with modern tendencies. It supplements the equipment of the mind with some general notions of art—vague, perhaps, at first, but later on to be crystallised into definite and defensible principles; it encourages in due time—always presuming that we speak of an intelligent student — the study of the history of epochs and of styles; it enables him to gaze upon fine works of art, whether they be paintings or sculptures, jewels or engravings, chased silver or enamelled gold, with the seeing eye, enables him to thrill in response to the touch of the long-dead artist, to know what a man meant, and how he felt when he laboured for long, splendid hours to bring to birth a thing of beauty and enduring joy. "Encourage the student," wrote Ruskin, "in sketching accurately and continually from Nature anything that comes in his way. . . . You have often to obtain beauty and display invention without direct representation of Nature, yet the principle is perfectly simple. If the designer of cups and vases and the like exercises himself continually in the imitation of natural form, he may pass down into all kinds of geometrical or formal design with safety and noble results."

Too much emphasis, therefore, cannot be given to the importance of a judicious selection of teachers. Each trade ought to be completely and exhaustively looked after by experts in that particular branch of education. It ought to be, so to say, artistically self-supporting. The self-importance of the average present-day teacher is to a certain extent a hindrance to the student. If a teacher would begin by putting himself at the level of the pupil, endeavouring to ascertain what is in the pupil's mind, here and there making a suggestion which might seem of no use to a listener, but which by its tactfulness might inspire one still better from the pupil, and thus breed in him self-confidence and a harmless conceit, he would not only be aiding the young mind in its development, but recompensing himself; for he would perceive

a little of the magnificence of the fresh, untrammelled brain grasping eagerly at what is essential to it. As a consultative committee of the trade, we are endeavouring to evolve the type of teacher required.

You will have it in mind to say, perhaps, in reply to my enthusiasm with regard to the introduction of artistic methods and designs into the articles of use and ornament which it is the especial province of the goldsmiths' and silversmiths' trades to produce, that all this is of little practical value unless the public will show some artistic predilections as well—that, putting it baldly, we cannot make pretty things simply to be looked at. I am happy to be able to anticipate any such hypothetical comments by stating that, along with the return of the craftsman, there are plentiful signs that the public is showing a remarkable revived interest in articles of beauty. "Art in England has never been dead," said Mr. A. Gilbert, R.A., "but only hibernating; its revival has come about chiefly through the great educational advance in the country, and the possibilities of study that have come with it." It is indeed time that something happened. What are we to think of the state of the goldsmith's art, formerly so dignified, so pure, so securely set on its pinnacle of fame throughout Europe, when imitations and the cheapest of gilt, worthless things degrade it every day in all our shop windows? How is the fine craft of the silversmith fallen when we descend to the kitchen and scullery for designs; when drapers, stationers, and chemists sell by the hundred-thousand trumpery articles and gewgaws of every description, stamped out of silver thinner than paper—silver that you can dent easily with the pressure of a finger-nail! Again, how great an anomaly is it to value a man's work by its weight in ounces, disregarding its loveliness, its evidence of careful, sensitive craft-labour! Truly, a few years ago it seemed as though the art of the worker in precious metals had sunk beyond redemption. Fortunately, as I observed, there is now a rapidly increasing proportion of the public, educated in matters artistic, capable of appreciating really good work, and insistent upon getting it, and willing to pay a fair price for it. My fear is that the scheme of educating the workmen will only partially succeed unless the men through whom the creations are to reach the larger public are equally tutored in art—I mean the retailers, who alone come into close touch with the purchasers. Even this difficulty will, I believe, be gradually surmounted, since any scheme which affects the manufacturing section of the trade must react upon the retailers.

Finally, permit me to affirm that this enterprise on behalf of which I speak, the interests of which I have so nearly at heart, is of a kind which, if wisely directed, will mark an epoch in the annals of commerce and of my own trade in particular, and will mark, too, a notable advanced stage in the evolution of the British applied arts especially. What final form the scheme will take cannot as yet be foreseen, but it is impossible to mistake the significance of the work, and of the persistence with which it is being carried on. By scholarships, and by annual professional competitions in design and artistic work of all kinds, we seek to encourage the development of a true taste for the beautiful; and I wish especially to emphasise the fact, already referred to at some length, that art is a most potent refining influence on the whole life of men and nations. We must follow out our mission—for such we feel it to be—perseveringly, undeterred by temporary checks or fleeting failures; we must mark the way, set high examples, remind ourselves that a country is great because of the greatness of its individuals, its industries, and its commerce; and that a nation is artistic because its individual men and women have listened to the divine call of beauty, and have attempted to pass on to the world its haunting, unforgettable tones.

In our way, we have made a beginning. It may seem small at times, but great progress has already been made, and it may turn out to be the lever to move the overwhelming weight of dullness and apathy that has rested upon an ancient and artistic craft for now nearly three generations. If those present, many of whom have enriched art, will now discuss the question freely, it will be a powerful encouragement to the movement.

Permit me to thank you, as a Society, most warmly for allowing me to read this paper upon a problem, the solution of which must interest every true lover of art—a problem which, when solved, will bring back the halcyon days William Morris must have borne in mind when he wrote: "Art is the expression of the workman's joy in his labour."

DISCUSSION.

The CHAIRMAN, in opening the discussion, said the favour with which his audience had received every paragraph of Mr. Heming's lecture, and the applause with which at the close they had emphasised their approval of it, made it really

superfluous for him to say more than how heartily he had shared their pleasure in it, and with what clearness and strength of conviction he sympathised with the views and opinions expressed by Mr. Heming on the past history, the present position, and the hopeful future of technical education in the artistic crafts of the United Kingdom. It was indeed a great privilege for us all, and a great encouragement for those of us who might be occupied as the business of our lives in these manufactures—using that word in its original sense as the antithesis of "machinations"—to have heard from so distinguished a practical authority as Mr. G. B. Heming, and out of his own mouth, how unhesitating was his confidence in the British workman, in every department of craftsmanship, if he were but adequately educated for his handiwork, and properly paid for it—an honest living wage; and how successful he had been in initiating something like a revival of the old system of apprenticeship for the education of workmen in his (Mr. Heming's) own trade of jewelry and goldsmithing; and to have been enabled, furthermore, to judge for themselves, from all they had heard there that evening, that Mr. Heming's prognostications of the prosperity awaiting our British industrial arts or artistic industries were as well founded and sagacious as they were enthusiastic and inspiriting.

He was particularly pleased in having found Mr. Heming so strongly insisting that students of art, devoting themselves to the practice of the industrial arts, should have previously had some experience of the trade in which they proposed to earn their livelihood; that is, of the character and working up of the materials, stone, clay, wood, wool, cotton, linen, silk, copper, brass, silver, gold, and gems, etc., used in the manufacture of sumptuary goods for household and personal use and ornament. In this way only should we ever get British art-workers of the type of the perfected hereditary handicraftsmen of the Indian democratic trades-union villages and caste guilds; the real makers, and the maintainers, through every economic and political catastrophe, however revolutionary, of the true greatness of India—India of the Hindus. The description given of the craftsmen of Anterior Asia in Ecclesiasticus xxxviii. exactly applied to them, and was, moreover, so profitable for our own instruction, correction, reproof, and stimulation, that he would quote it at some length. After saying how the ploughman gloried in his goad, and set his heart upon turning a straight furrow, and was wakeful to give his heifers their fodder, it continued:—"So is every artificer . . . . They that cut gravings of signets. And his diligence is to make great variety. He will set his heart to preserve a good likeness in his portraiture; and will be wakeful to finish his work betimes. So is the smith by the anvil . . . . He will set his heart upon perfecting his work . . . . and his eyes are upon the pattern of the vessel . . . . and he will be wakeful to adorn them perfectly. So is the potter . . . . and all his handiwork is by number . . . . And he will be wakeful to make clean his furnace. All these put their trust in their hands, and each becometh wise in his own work. Without these shall not a city be inhabited. And men shall not sojourn nor walk up and down therein . . . . But they will maintain the fabric of the world (or 'age'). AND IN THE HANDIWORK OF THEIR CRAFT IS THEIR PRAYER." This was a photographic picture of the landscape, life, and labour of the Indian Hindu villages, and of the all-pervading and sustaining, and all-comforting and sanctifying religious spirit that animated them; and their joy in their gods was their strength. We might have our Territorials, "all the King's soldiers, and all the King's men," and all were needed, to their full "establishment," but the "Trained-bands" required for the enduring conservation and defence of the United Kingdom, were our technically and artistically trained British workmen; and in their making or marring was directly involved the making or the marring of the entire British Empire.

But what he most sympathised with in Mr. Heming's paper was the depth and steadfastness and devoutness of the feeling that emphasised it throughout—as it ever had all his work, whether as a jeweler and goldsmith, or as an educational reformer on behalf of his trade. In this respect he recalled to his mind the saintly John Hungerford Pollen, of whom he (the Chairman), when occupying the chair at his paper on "Renaissance Woodwork in England" (on January 5th, 1898), said:—"Mr. John Hungerford Pollen always reminds me of Theophilus the Monk, who in his book on the 'Industrial Arts' recommends the study of them as a recompense of heavenly price; and asks those who found pleasure and profit in his books to pray for the pity on him of Almighty God, Who knew that he had written the things (recipes, etc.) to be found therein, not for the praise of men, but for the greater glory of Him in whose divine counsels and genius every artist was a participator." The latter thought was expressed in the Book of Wisdom ix. 8-10. Again we read in Exodus xxxi. 2-6 of the master craftsmen, Bezaleel and Aholiab:—"And I have filled them with the Spirit of God, in wisdom, and in understanding, and in knowledge, to devise cunning works in gold, and in silver, and in brass, and in cutting of silver for setting, and in carving of wood in all manner of workmanship."

Both art and religion had each its own special content; but the truth was that all art which rested on earnest and efficacious feeling inevitably became inspired by, and in turn inspired, religious emotion, and reached its highest heights of achievement only in the deliberate expression and exposition of religious feeling—and if "the beauty of holiness" and the holiness of beauty were not absolutely one, they were at least inseparable from each other—twin streams flowing from the same fountain-head, and to the one self-same infinite and mystic sea of tranced immortalities.

Mr. S. LOWEN (Secretary of the Goldsmiths' Trades Union) paid a high tribute to the labours of the author during the last few years in bringing about a betterment in the industry. He thought, however, that Mr. Heming took a rather pessimistic view of the ignorance of the British workman and the number of foreigners in British workshops; indeed, he believed there were not more than 30 per cent. of foreigners in the diamond and gold industry at the present moment. With regard to the question of artistic work, there was a tendency of many employers nowadays, when a workman had put all his soul into an article, to dismiss him for being too long over it. Only the previous evening he had had a case before him of an enthusiastic workman—quite an artist—who was really a versatile man in his ability, but who was dismissed for being too long completing his work. The employer was, perhaps, not so much to blame as the shopkeeper. Mr. Heming had referred to the question of educating the workman, but in his (the speaker's) opinion it was the shopkeeper who needed education, from the artistic point of view. The average salesman had no eye to taste, and could not point to any of the beauties of a particular article which he might be selling, and all the credit which he (the speaker) could give that individual was the credit for not trying so to do! With reference to designs, the system in London did not obtain in Paris. The Masters' Association in Paris were not cutters of prices. He instanced a case where an employer informed him some time ago that he had left a very high-class design, which involved considerable labour, with a West-End firm. Manufacturers called and gave different estimates, with the result that the lowest estimate obtained the work. Now, that was neither fair to the workman, to the industry, nor to the public. Mr. Heming's efforts, however, during the last few years had given such a fillip to education that the trade would never again retrograde. The Franco-British Exhibition gave great encouragement to everybody in the industry, and he thought the author took heart when he saw the splendidly improved work there. He suggested to the Committee of the Art Council, with reference to their competitions, that too much attention should not be paid to the amount of work a man could do in a given time. That, he was of opinion, was a great drawback to the competition, and he hoped for an alteration in that respect in the future.

Mr. JOHN WILLIAMS thanked the author for his paper, especially for the very hopeful tone he had taken throughout with regard to the trades and the education connected with them. The account Mr. Heming gave of the schools in Geneva and Paris was most valuable, but it must be remembered that in comparing the work of those schools with the schools in this country, the school in Geneva had been in operation for thirty-five years, and the French school for forty-six years. It was only within the last few years this country had possessed such an institution as the Goldsmiths', Silversmiths', and Jewellers' Art Council, and therefore it was at least thirty years behind both Switzerland and France. There were two points which, in his opinion, stood out above any others in Mr. Heming's paper. The first was as to the necessity for compulsory education of apprentices and learners. It seemed that in the schools mentioned in the paper, compulsory attendance was always the rule. That applied also to most of the German schools. Secondly, there was the absolute necessity for the employers and workers to take a greater share in the future in the matter of art education amongst the younger members of the trade. On both those points he maintained that England was not on the same level as the Continental schools. In England, up till the last year or so, the voluntary attendance of boys and young men at evening classes—after they had left work—was not to be depended upon. Anyone who had experience of the matter would know that the attendance was affected by extra pressure of work before Christmas, the slackness after that time, and bad weather. It certainly was asking a great deal of a boy who had been in a shop all day to attend evening classes. But, in spite of those obstacles, many boys attended, and really did good work. Those difficulties, however, did not apply to the classes which had been established by the Goldsmiths' and Silversmiths' Art Council, as the boys were allowed to attend to their lessons in their employers' time, and therefore much more regular attendance and systematic work resulted. Even under the classes as they existed at present, however, the attendance did not allow of efficient teaching in many of the subjects. Mr. Heming spoke of classes of fifty or sixty in Paris schools. Even with the help of the Goldsmiths' and Silversmiths' Art Council, classes of that kind could not be arranged in this country. What was obtained was one class of boys in their first year, and another class in their fifth or sixth year, and classes composed of boys who came from different kinds of shops. On the other hand, the Continental schools, by having a larger number of pupils in their classes, could better organise the work, and give the subjects greater division and attention. The author had given a very good account of the grade of teacher that he wished evolved. He (the speaker) did not think that "evolved" was really the right word. He was sure that there were already in existence teachers who were not only sympathetic, but anxious to do the best they could for the students—men and women who came to them for advice and assistance; and if the Goldsmiths' and Silversmiths' Art Council would encourage them, they would rise to far greater heights than they had in the past. The co-operation of the Council and educationalists, he felt sure, would result in a system of education which would in time equal that of the Continental schools.

Dr. W. Garnett (Educational Adviser to the London County Council) said he was no artist and no craftsman, and was not qualified to address the audience on any subject bearing upon art, but he would be greatly helped in his work if some gentleman could give him some suggestions, firstly, on the extent to which machinery and the study of machinery should be introduced into schools of arts and crafts in connection with the training of the designer, and, secondly, on the extent to which such machinery, if at all, should be introduced in connection with the training of the craftsman. By machinery he did not mean simply machine-tools, which were mere adjuncts to handwork, but machinery of more or less automatic character. He had recently seen a manifesto from an Association of Art Masters, in which it was said that the schools had not been enabled sufficiently to come into touch with manufacturers in connection with the design and production of machine-made artistic goods, and they urged that some steps should be taken in that direction. Communications in the public press, and elsewhere, had also appeared, urging the same point, namely, that the machine had come to stay, and that unless the artist was to be dominated by the machine, he must become its master, and that it was important the schools should become thoroughly conversant with machine production in order that their designs might be adapted thereto. Hitherto he had been unable to get any but simple suggestions with regard to the particular kinds of machinery that should be introduced. For instance, he had been told that a hand-loom was most important in connection with the design of textiles, and that spinning machinery for metals was equally important in craft schools in which metal work was being carried out; but beyond those two comparatively simple suggestions he had been unable to learn what sort of machinery was required. He was strongly convinced that the designer should know all that was to be known respecting the limitations of his design which were necessary for its adaptation to the machinery by which it was to be produced, but that did not necessarily mean that the machinery itself was to be introduced into the schools. It seemed to him that, at any rate in the training of the designer, what was most wanted was that such co-operation between the manufacturer and the schools should be obtained as would enable the young students to be taken in small groups over the works to see the machinery actually producing, and to learn as much about it as was necessary to guide them in connection with their designs. He had generally recognised the principle that in the training of the craftsman, whether in engineering, building, or art, the main essential was to produce a good hand-worker, and that afterwards he would quickly learn the use of labour-saving machinery when he got the opportunity.

Mr. Alan S. Cole, C.B., agreed entirely with the reader of the paper in what he had done and was doing in connecting together trade and educational interests. It was most important that such a connection should exist. Although the author had not referred to them—perhaps intentionally—there were in Birmingham and Sheffield just as fine schools of art in their way as any on the Continent. With regard to the training of people in art crafts, and the application of design to particular materials of all sorts, as far as the schools of art in this country were concerned, the Government by its grants and regulations—some of which, however, were very harassing—had for the last fifteen years encouraged them as far as possible to take up the direct instruction of design in connection with various materials, but the outcome of the movement was not appreciated by the public. If any one went, say to South Kensington, and saw one of the National Competitions, he would find some extraordinarily fine work, but the public did not care one jot or tittle about it. The Government was a great deal to blame in the matter; it gave most meagre accommodation to the exhibition, and as time went on the exhibition would probably be set aside altogether. He thought it was a crying shame that the Government, who professed to encourage design and art in all its forms, should extinguish practically that most important annual exhibition, of which the public could know hardly anything at all.

Mr. J. S. Bell said he desired to refer to the question of patronage. Those connected with the trades mentioned in the paper had made great efforts to produce the highest class of workmanship possible, and any who visited the West-End shops would be surprised if they were, so to speak, to get behind the counter, to see the art treasures there collected. There were some magnificent collections in the British Museum and elsewhere, but he could assure the audience that the same could be found at any of the West-End establishments. The author had referred to the Art Council, but such a scheme was nothing new; there had been art schools and art training during all his experience of the trade, which extended over thirty-five years. What he did deplore was the change of ideas. The aristocracy of this country were so enamoured of their motor-cars and such like, that they gave no thought to art. The idea at the present time seemed to be that anything in art must be old and antique, and then it was looked upon as a sort of idol, but to anyone who knew anything about the manufacture of such articles it was a mere whim or fancy. Such things, he maintained, could be produced at the present time if only the public would give the necessary encouragement and appreciate high-class work. If they did give that encouragement it would give a great incentive towards art training.

Mr. Henry Wilson said he felt the subject raised by Dr. Garnett was of great interest, but great

reflection was necessary before one could give utterance to any opinions that were likely to be of value. The first thing he would do would be to repeat the remark made by Dr. Garnett, that the man must dominate the machine, because that was only common-sense. He would quote for example the die. The die, by which the most perfect piece of work of art the world had ever seen —the Greek medallion—was created, was nothing more nor less than a machine. There was no reason why works of art of a very noble and beautiful character could not be repeated *ad infinitum*, because everything depended, not upon the machine, not upon the use of the machine, but upon the design of the machine; that was to say, it was the man behind the machine who always had to be considered. It did not matter from whatever point of view the question of art was regarded, it was not the tool or the machine or the education or the training—it was the man. Therefore, with regard to the points raised by Dr. Garnett, he felt there was so much to be said that a conference of educationalists and artists and workmen of all kinds should be held in order that the matter might be thoroughly thrashed out. In his opinion, there was not at the present time any education of any kind, artistic or otherwise, which was properly organised; the whole system of education was in a haphazard state, and for no earthly reason. There was splendid raw material at hand, and why should not the best be made of that raw material? He fully believed, and he had had some considerable experience, that there was nothing in the world to equal the young English boy, who had an almost divine appreciation of beauty, and a sensitiveness to form and line which would not be found in any other part of the world. It certainly would not be found in France, where there was an amazing and wonderful intellectuality, but that which made the English boy's charm was not present; it was steel put against fine gold. That fact, however, did not blind him to the extraordinary defects in this country's scheme of education. With regard to the question of spinning, he could not help feeling that there was a great future for the use of spinning in the production of simple, beautiful things for everyday use. He did not think spinning ought to be used in what one might call monumental works; for instance, cups of any sort, or chalices, the whole of which work ought to be done, from the base to the summit, absolutely by hand; but for things of everyday use he did not see why there should not be a group of artists, who might be called spinning artists, who would evolve out of their experience a whole series of beautiful and lovely contours, such as could be seen on a Greek vase. The Greek artist was a consummate contour artist because he had a consummate knowledge of the human figure. He would like to suggest that there should be some attempt made by the trade to develop spinning works of contour. He could not sit down without publicly thanking Sir George Birdwood for that wonderful book of his "The Industrial Arts of India." He (the speaker) owed more to that book than to any other that had been written on the subject of art, and he never looked at it without feeling his gratitude welling up from within him. He used to wonder how Sir George had written such a book, but he was quite certain now that he had not written it—the Spirit of India had taken hold of Sir George Birdwood and had inspired him.

A vote of thanks was accorded to the author for his interesting paper.

Mr. Heming, in reply, said he felt more than gratified by the reception of his paper, and also by the large company present, representing as they did a great section of the silversmiths, jewelers, and goldsmiths of London. He could only hope that the remarks he had made would strike home, and that the Art Council, which was now in its third year, would be supported to a larger extent. He trusted that the Goldsmiths' Company, which was supposed to represent the trade, would come to the rescue and not only morally but financially support the Council. He was pleased to hear from Mr. Lowen that he was wrong about the percentage of foreigners in the trade. With regard to Dr. Garnett's remarks about machinery, he (the author) was absolutely opposed to its introduction. If once it was introduced, hand-workmanship would never be reverted to. The whole object of his Society had been to raise the standard of work by doing away with machines, and to produce work such as the old masters in the earlier centuries did. He wanted the public to appreciate such work, and if they did, it could be produced.

ARTS AND CRAFTS.

Some Pottery for the Turin Exhibition.—It was allowed on all sides that the pottery exhibits from this country were amongst the most interesting features of last year's Brussels Exhibition. It was not merely that a good number of manufacturers showed, but that their wares were marked by a great advance in a number of directions. There has, therefore, been a strong feeling that we must at all costs send a fine collection of pottery to Turin to follow up the good impression that has been created. A distinct portion of the British building at the forthcoming exhibition has been set aside for ceramics, and a number of the principal firms are contributing towards what will be, it is hoped, an epoch-making exhibition of British pottery. The largest exhibit will be that of the Pilkington Tile and Pottery Company, who have taken a double space, and intend to show a large octagonal case full of painted lustre, from which will radiate eight ordinary exhibition cases, one or two of which will be given up to lustre, whilst others will illustrate a variety of different glazes and methods, arranged according to colour.

The vases to be exhibited at Turin were shown at Clifton Junction for three days before they were sent off, and they formed a remarkably fine collection. It was, of course, in the painted lustre for the centre case that the interest of the little exhibition culminated. Mr. William Burton, the managing director of the company, and his brother, Mr. Joseph Burton, have been working for some years to produce new effects on old lines—not by haphazard methods, but by the most careful following out of scientific principles. The results of their labours, so far as they have gone, have been shown at previous exhibitions, but the examples going to Turin mark a very great step forward. In the first place, their range of colours has been materially increased. They have been producing painted lustre work on a variety of coloured backgrounds for some time past, and the available grounds now include, besides more ordinary colours, a very rich deep blue, as well as a tint closely resembling a powder blue and a kind of powder green. Some very beautiful effects are obtained by so scheming the colours that the background tint is often deeper, and sometimes quite different on the lower part of the vase. People who know the difficulties incident to the firing of lustre, and of special pottery glazes, will appreciate the mastery over the means of production which the power to do this kind of thing at will involves. The newest and most striking colour-scheme is given by a small group of vases in which the prevailing tint is a kind of peach blow, which varies from green through a delicate pinkish shade, to a beautiful fiery sunset colour. The highest point to which pictorial representation can go without overstepping the mark is well illustrated in a large vase, very simple and severe in form, on which is painted a procession of sailing ships. The green and orange, and the endless gradations of colour between the two, succeed in producing a peculiarly tender colour arrangement suggestive of something between sunset and moonlight—and one feels that all the essentials of artistic effect are there without any sacrifice of the reticence and the breadth which the material demands.

A few of the bowls are slightly modelled both inside and out by hand, and by this means they gain a certain personal quality at the same time as they afford a more varied surface for the display of the lustre. The slightly raised slip patterns which occur on a few of the pots also help to display the beauties both of the lustre and of the glaze to full advantage. The designs with which the vases are decorated vary from flatly treated figure and animal forms to ornament pure and simple. Some of them are sufficiently modern in character to belong completely to the twentieth century, whilst others, and by no means the least successful of them, are reminiscent of old work. This is specially the case with some of the ornamental allover patterns, where the colour-scheme of the painting recalls instinctively old Oriental ceramics. It is by no means the least of the makers' achievements that they have succeeded in producing something which, while it recalls the various lustre wares of the past, sometimes in colour, sometimes in treatment, sometimes in design, is distinctly and distinctively of our own time. One feels that, had there been no Persian, no Hispano-moresque, no Italian lustre ware, these vases would never have seen the light, but while the makers have learnt all they can from the old master potters, their work is pre-eminently their own. It is only reasonable, when one comes to think about it, that as men of old time have had their share in the evolution of the modern man, so the art of the past should play its part in helping to produce the art of to-day. It is to his grasp of this fact, not usually appreciated at the present time, almost as much as to his scientific knowledge and ability, that Mr. Burton's remarkable success is due. Some of the plain lustre pots are beautiful in colour, and the smoke-like effects in particular are wonderfully pleasing. The remaining exhibits consist largely of crystalline and other transmutation glazes, and of eggshell, fruit skin, and other glazes which give a matt surface. The fiery crystalline glaze is peculiarly fine, whilst the more subtle colour produced by the break of some of the more delicate coloured glazes is hardly less beautiful. The most interesting of the matt glazes are the blues and greens. The old bright blue has now given place to a full blue with a greenish tinge which brings it more towards a peacock, and the effect of this on a large pot, where one part looks bluish and another greenish, is very attractive. Again, some of the greens slightly speckled with brown have a very delightful quality. A show like this should produce a great deal of comment at Turin, and will certainly more than hold its own against all competitors.

Slovak Embroidery.—We have been rather overdone of recent years in England with exhibitions of the peasant art of various countries and peoples, but the little show of Slovak art at the Doré Gallery is well worth a visit. The pottery, though characteristic enough, is rough ware covered with tin enamel, which calls for little comment, but the embroidery is really remarkable. The handiwork of a Slav people settled in Central Europe, it offers, both in technique and in design, an interesting example of work which, though neither wholly Eastern nor Western, has a good many characteristics both of the East and of the West, and it merits study by all those who are interested in the connection between Eastern and Western art, or who think they know something about the design and workmanship of the embroidery of the Near East. There is a certain amount of Slovak embroidery scattered about the museums of central Europe, but as it is generally labelled Hungarian (since the majority of the Slovaks live in Hungary) it is generally taken to be the work of Magyars, and probably few of those who were interested in the show of needlework at the Hungarian Exhibition at Earl's

Court some years ago realised how much of the best embroidery was Slovak. At Bond-street some of the most interesting work might almost pass for Persian from its method and its colouring, whilst other pieces are quite unmistakably European. One form of needlework which the Slovaks have carried to great perfection is a sort of pierced work (such as used in early Victorian days to be called Madeira work) executed usually in yellow on white, or in blue on black, with sometimes the addition of further ornament in gold and silver thread. Most of the silk embroidery is characterised by its vivid colouring which, for all its brightness seems never, at least in the older work, to strike a false note. The gold work is remarkable partly because a good deal of it is stitched in fine gold thread which is carried through the material, instead of being couched upon it, and partly for the characteristic patterns worked over stiff cardboard. The chasuble embroidered by a Slovak peasant woman from her own (evidently traditional) design, is a very interesting example of how well good peasant work can be adapted to ecclesiastical uses — but one could wish that the figure-panel in the centre had been omitted; it is out of harmony with its surroundings, and not the best type of figure embroidery.

HOME INDUSTRIES.

The Coal Mines Bill.—It was said here last week that it was to be regretted that the second reading of this Bill was not preceded by the usual full discussion. It is a Bill of great complexity, dealing with matters of great moment to a large section of the industrial community, and whilst on the whole the measure appears to commend itself to those most concerned, and best able to judge of its merits and defects, some serious criticism has to be answered. The mining danger which attracts the greatest amount of public attention is explosions, and here it is alleged the Bill is defective, is indeed said to be distinctly retrograde. The section in the Bill dealing with the use of safety-lamps says:—"No light or lamp other than a locked safety-lamp shall be allowed or used (*a*) in any seam where the air current in the main return airway is found normally to contain more than half per cent. of inflammable gas." Sub-sections of this section provide for the use of safety-lamps in parts of a mine, but do not affect the general question. Now it is said, among others by Mr. George H. Winstanley, who speaks with authority, that such a determining factor as that named—more than half per cent. of inflammable gas in the main return airway — would exempt from the general use of safety-lamps a large number of collieries where safety-lamps are, and for years have been, used. The best ventilation is generally to be found in the mines which are the most dangerous as regards the freedom with which fire-damp is given off, and these are the mines in which, as a result of that good ventilation, there is rarely "more than half per cent. of inflammable gas" in the main return airway. To quote Mr. Winstanley:—"There are many collieries in Lancashire in which the ventilating volume amounts to from ten thousand to twenty-five thousand tons of air per twenty-four hours. On the other hand, in those mines which claim to be free, or relatively free, from fire-damp, the ventilation is often poor, and whilst it would be quite easy to keep below the determining limit in the main return airway, there may be dangerous proportions of gas in other parts of the mine." That section of the Bill dealing with the compulsory adoption of safety-lamps seems to be in need of stiffening, and doubtless this will be emphasised in the discussions at the conferences between the owners and the men, and in Grand Committee.

Anglo-Egyptian Trade.—There is a good deal in what Mr. Thomas Roberts, a British commercial agent in Egypt, says about the possibility of expansion of British trade with Egypt, if only British merchants and manufacturers would pay more attention to native requirements by getting more in touch with the natives. The principal means by which the British trading position in Egypt can be improved seem to be three: (1) That English commercial travellers should be able to speak French; (2) that catalogues should be printed in French as well as English; (3) that there should be an exhibition of British industries supported by the Board of Trade. An effort is now being made to arrange for such an exhibition to be held in Cairo. Whether it will be successful depends upon the willingness, or otherwise, of the British Government to give it the necessary support. Mr. Roberts, who speaks from a long experience of Egyptian requirements, says there is a preference for the following articles of English make:—Cheap crockery, sanitary ware, boots, underclothing, cloths, ready-made suits, linoleum, furniture, clocks, carpets, silvered glass, fishing tackle, guns, jewellery (cheap), confectionery, flour, pickles, biscuits, soaps, paints, oils, whiskies, pitch, paper, rope, hats, buttons, pins, fencing, tinplates, lace curtains, salt fish, matches, bedsteads, bicycles, motor-cars, saddlery, pianos, gramophones, threads, travelling bags, sporting requisites, worsteds, lead piping, cast-iron pipes, railway, tram, and ambulance fittings, etc. Generally these articles are required in cheap qualities.

The Boot and Shoe Trade.—Before the present United States tariff came into effect the annual exports of boots and shoes from the Leicester district to the United States were quite nominal, but for last year they amounted in value to £17,000. The American Consul for the district reports that they are invoiced as "high-class walking boots and shoes." Shipments of these goods have been made to Cincinnati, Boston (two firms), New York (five different firms), Philadelphia (two firms), San Francisco, Pittsburg, Columbus, Ohio (four firms), Chicago, Cleveland, Kansas City

(six firms), and Portland, Oregon. A good proportion of the boots and shoes exported to the United States and Canada are shipped at the Manchester Docks, the goods being forwarded by rail direct from the manufacturing centres to alongside the steamers, thus reducing the cost of transit and handling of the goods to a minimum. Through railway rates are quoted from Nottingham, Leicester, Kettering, Northampton, and other manufacturing centres, not only to the Manchester Docks, but also through to the Western States. The saving in delivering from the works to f.o.b. Manchester, compared with Liverpool, varies from 2*s.* 6*d.* to about 4*s.* per ton.

Short Time in the Cotton Industry.—As was anticipated in these Notes, the percentage of spinners required to bring about short time, that is to say, 90 per cent., has not been obtained. Many members of the Federation believed the proposal to be inopportune. The *Cotton Factory Times* admits that "the immediate necessity for going on short time is hardly as pressing as it has been on some other occasions," but thinks that "a compulsory Saturday stoppage all round would bring about regularity of employment on the remaining days." If that were so there would be much to be said for the stoppage, but would it be so? The number of spindles would probably increase if high profits were made. In 1903 and 1904 there was short time. In 1903 it lasted fourteen weeks, and affected both American and Egyptian cotton; in 1904 the American mills were on short time for thirty-six weeks, and the Egyptian mills for four weeks. This was quickly followed by an unexampled increase of spindles, which supports the conclusion that there was a connection between the expansion and the large amount of short time that preceded it. As it was then so it might be again.

NOTES ON BOOKS.

DICTIONARY OF ENGLISH AND SPANISH TECHNICAL AND COMMERCIAL TERMS. By William Jackson. London: E. & F. N. Spon. 2*s.* 6*d.* net.

This little book has been designed as a dictionary in two parts—English-Spanish and Spanish-English—of technical and commercial terms used principally in the iron, steel, hardware, and engineering trades. As the author remarks, the rapid development in these branches has brought into use many technical words and terms which are not given in the ordinary dictionaries, and are very hard to find. It is, of course, extremely difficult to draw up an exhaustive list of expressions used in any trade, and in a book of this sort one must look for a few omissions, but these appear to be somewhat numerous. A casual glance, *e.g.*, fails to find the words "braze," "brazier," "mud-guard," and "span"; but in spite of this the book supplies a very decided want, and should prove useful to many engaged in the trades concerned.

MEETINGS OF THE SOCIETY.

ORDINARY MEETING.

Wednesday evening, at 8 o'clock:—

APRIL 5.—HENRY L. HEATHCOTE, B.Sc., "Wheels, Ancient and Modern, and their Manufacture." The Hon. RICHARD CLERE PARSONS, M.A., Vice-President of the Society, will preside.

Dates to be hereafter announced:—

FRANK M. ANDREWS, "Architecture in America."

Professor RAOUL PICTET, "Les Basses Températures."

Sir WILLIAM ABNEY, K.C.B., D.C.L., D.Sc., F.R.S., "The Quantitative Measurement of Colour-Blindness."

HAL WILLIAMS, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

NOEL HEATON, B.Sc., F.C.S., "The Production and Identification of Artificial Gems."

A. W. GATTIE, "London Transport."

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

APRIL 27.—Sir THOMAS HENRY HOLLAND, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India." Lord AVEBURY, D.C.L., LL.D., F.R.S., will preside.

MAY 25.—W. R. H. MERK, I.C.S., C.S.I., LL.D., "The N.W.F. Province of India."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

APRIL 4.—Captain R. MUIRHEAD COLLINS, R.N., C.M.G., Official Secretary in Great Britain for the Commonwealth of Australia, "The Commonwealth of Australia." The Right Hon. Lord DENMAN, K.C.V.O., Governor-General Designate of Australia, will preside.

MAY 9.—F. WILLIAMS TAYLOR, "Canada and Canadian Banking."

CANTOR LECTURES.

Monday Evenings, at 8 o'clock:—

ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

May 1, 8, 15, 22.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 3...Victoria Institute, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Rev. Canon Girdlestone, "Indications of a Scheme in the Universe."

Farmers' Club, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Professor J. H. Priestley, "Electricity as a Factor in Crop Production."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 7.30 p.m. Mr. W. R. Baldwin-Wiseman, "The Administrative Aspect of Water Conservancy."

Chemical Industry (London Section), Burlington House, W., 8 p.m. Mr. C. Heycock, "Measurement of High Temperatures."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. D. Dinwiddy, "Annual Licence Values."

Engineers, Cleveland Institute of, Corporation-road, Middlesbrough, 7.30 p.m.

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Professor Selwyn Image, "Architecture in Paintings."

TUESDAY, APRIL 4...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Captain R. Muirhead Collins, "The Commonwealth of Australia."

Sociological, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8.15 p.m. Dr. D. S. Margoliouth, "The Universal Races Congress."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. M. Aurel Stein, "Explorations of Ancient Desert Sites in Central Asia." (Lecture III.)

Alpine Club, 23, Savile-row, W., 8.30 p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. J. W. Smith, "The Improvement of Highways to Meet Modern Conditions of Traffic"; 2. Mr. H. P. Maybury, "Recent Development in Road Traffic, Road-Construction and Maintenance."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. S. Gardner, "A Visit to Some Irish Antiquities."

Zoological, Regent's-park, N.W., 8.30 p.m. 1. Dr. R. T. Leiper, "Demonstration of Nematode Parasites obtained from Animals in the Gardens." 2. Mr. F. E. Beddard, "Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—I. On some Mammalian Tapeworms." 3. Mr. J. A. Morch, "On the Natural History of Whalebone Whales."

WEDNESDAY, APRIL 5...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Henry L. Heathcote, "Wheels, Ancient and Modern, and their Manufacture."

Geological, Burlington House, W., 8 p.m.

Public Analysts, Chemical Society's Rooms, Burlington House, W., 8 p.m. 1. Messrs. G. E. Scott-Smith and John Evans, "The Analytical and Microscopical Examination of Compound Liquorice Powder." 2. Messrs. Raymond Ross and Joseph Race, (*a*) "Note on Almond and Apricot Kernel Oils"; (*b*) "Constants of Chicken and Turkey Fats." 3. Mr. John Golding, (*a*) "Note on Gerber's 'Sensal' Milk Test"; (*b*) "Note on Abnormal Cotton Cakes." 4. Messrs. J. H. Coste and L. Myddelton Nash, "A Further Contribution to the Question of Turpentine Substitutes."

United Service Institution, Whitehall, S.W., 3 p.m. Mr. A. Colquhoun, "The Strategical Problems in the Pacific."

Royal Archæological, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Exhibition of the Embalmed Head of Oliver Cromwell, with a Short Description and History of the Object.

Naval Architects, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C. Annual Conference, 11.30 a.m. 1. Address by the Chairman. 2. Professor J. J. Welch, "The Problem of Size in Battleships." 3. The Hon. C. A. Parsons and Mr. R. J. Walker, "Twelve Months' Experience with Geared Turbines in the Cargo Steamer 'Vespasian.'" 4. Mr. G. S. Baker, "The National Experimental Tank and its Equipment."

THURSDAY, APRIL 6...Naval Architects, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 11.30 a.m. 1. Mr. J. T. Milton, "Diesel Engines for Sea-Going Vessels." 2. Mr. F. H. Alexander, "The Influence of Longitudinal Distribution of Weight on the Bending Moments of Ships among Waves." 3. Mr. J. Montgomerie, "Considerations Affecting Local Strength Calculations of Ships."—7.30 p.m. 1. Dr. R. E. Froude, "The Acceleration in Front of a Propeller." 2. Engineer-Lieutenant A. Turner, "An Investigation into the Stresses in a Screw Propeller Blade."

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Linnean, Burlington House, W., 8 p.m. 1. Miss S. M. Baker, "On the Brown Seaweeds of the Salt Marsh." 2. Papers on "The Genus *Salicornia*," by Dr. C. E. Moss (History, Synonymy, and Phylogeny), Mr. E. J. Salisbury (Characters of the Species), and Dr. Ethel de Fraine (Anatomy).

Child Study, 90, Buckingham Palace-road, S.W., 7.30 p.m. Dr. A. R. Abelson, "The Measurement of the Intelligence: with special reference to Mentally Defective Children."

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. F. Tutin and H. W. B. Clewer, "The Constituents of Rhubarb." 2. Messrs. A. W. Crossley and C. H. Hampshire, "6-nitro-3:4:3':4'-tetramethyldiphenyl." 3. Messrs. J. J. Dobbie, J. J. Fox, and A. J. H. Gange, "Diphenylene, a new Aromatic Hydrocarbon. Part I." 4. Messrs. T. P. Hilditch and A. E. Dunstan, "The Correlation of Viscosity with other Physical Properties. Part I. —The Ethenoid and Ethinoid Unsaturation." 5. Mr. E. P. Perman, "Chemical Action induced by Cathode Rays and Canal Rays."

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. A. Bone, "Surface Combustion and its Industrial Applications." (Lecture II.)

Architects, Society of, 28, Bedford-square, W.C., 8 p.m. Mr. Percy Macquoid, "English Furniture."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Mr. J. E. Taylor, "Wireless Telegraphy Working in Relation to Interferences and Perturbations."

Philatelic, 4, Southampton-row, W.C., 6 p.m. Display of Portuguese Reprints, presented by H.M. the King of Portugal.

Roentgen Society, 19, Hanover-square, W., 8.15 p.m.

Concrete Institute, Denison House, Vauxhall Bridge-road, S.W., 8 p.m. Mr. C. P. Taylor, "The Reinforced-Concrete Pier at Swanscombe."

FRIDAY, APRIL 7...Naval Architects, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 11.30 a.m. 1. Dr. H. Frahm, "Results of Trials of the Anti-Rolling Tanks at Sea." 2. Dr. H. S. Hele-Shaw and Mr. F. Leigh Martineau, "Steering-Gear Experiments on the Turbine Yacht 'Albion.'" 3. Mr. S. B. Ralston, "Description of a Stability and Trim Calculator." 4. Mr. C. E. Inglis, "General Propositions and Diagrams relating to the Balancing of the Four-Cylinder Marine Engine."—7.30 p.m. 1. Professor E. G. Coker, "The Determination, by Photo-elastic Methods, of the Distribution of Stress in Ships' Plating." 2. Mr. M. Ballard, "Some Notes on a New Design of Merchant Vessel."

Civil Engineers, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. E. E. Farrant, "Retaining Walls."

Royal Institution, Albemarle-street, W., 9 p.m. Professor Sir J. J. Thomson, "A New Method of Chemical Analysis."

Geologists' Association, University College, W.C., 8 p.m. 1. Illustrated lecture on "The Scenery of Gloucestershire." 2. Mr. L. Richardson, "On the Sections of Forest Marble and Great Oolite on the Midland and South-Western Junction Railway between Cirencester and Chedworth, Gloucestershire."

Medical Officers of Health, 1, Upper Montague-street, W.C., 5 p.m. Dr. F. Foord Caiger, "Cubicle Isolation."

British Foundrymen's Association (London Branch), Cannon-street Hotel, E.C., 8 p.m. Mr. P. Longmuir, "Brasses and Bronzes."

Malacological, Burlington House, W., 8 p.m. 1. Mr. G. A. Smith, "A List of Marine Shells occurring at Christmas Island, Indian Ocean, with Description of New Species." 2. Lieut.-Colonel H. H. Godwin-Austin, "Description of *Oxytes Beddomei*, n. sp. from Burma." 3. Major A. J. Peile, "Note on the Habits of *Eurychlamys platychlamys*."

SATURDAY, APRIL 8...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Radiant Energy and Matter." (Lecture VI.)

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FRIDAY, APRIL 7, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

CONVERSAZIONE.

The Society's Conversazione will be held this year at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday, May 30th, from 9 p.m. to 12.

PROCEEDINGS OF THE SOCIETY.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 5th, 1911; The Hon. RICHARD CLERE PARSONS, M.A., M.Inst.C.E., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society :—

Cope, Thomas, 27, Rosenthal-road, Catford, S.E.

Das, J. N., F.R.G.S., M.R.A.S., Khalispur H. E. School, Khulna, Bengal, India.

Gibson, Captain R. R., Immigration Office, Essequibo, British Guiana.

Giveen, Richard Lockwood, Colet-court, Hammersmith-road, W.

The following candidates were balloted for and duly elected members of the Society :—

Curtis, Professor Mattoon Monroe, A.M., Ph.D., 2045, Adelbert Road, Cleveland, Ohio, U.S.A.

Farrington, Henry, M.Sc., B.Eng., Popular Mechanics Company, Chicago, Illinois, U.S.A.

Howarth, Joseph, Kirkdale, Oldfield Lane, Dunham Massey, near Altrincham, Cheshire.

Samaddar, Professor Jogindra Nath, B.A., The College, Hazaribagh, Bengal, India.

The CHAIRMAN remarked that very few words were necessary from him in introducing the reader of the paper, Mr. Henry Heathcote, who was well known to many members as having devoted much attention to perfecting wire wheels. As everyone, every day of their lives, made use of wheels, all were very intimately interested in the question of their perfection. He anticipated a paper of very great interest to all.

The paper read was—

WHEELS, ANCIENT AND MODERN, AND THEIR MANUFACTURE.

By HENRY L. HEATHCOTE, B.Sc.

SCOPE OF THE PAPER.

The object of this paper is to present an account of some of the most ancient and most modern wheels, to describe their form, the materials used in their construction, and, as far as possible, the methods employed in their manufacture.

To prevent the account becoming too sketchy, it will be limited almost exclusively to vehicle wheels, and no attempt will be made to follow the application of wheels in the many arts which employ them.

The important advances which were made by the ancients when they began to employ wheels and rotating members in their mechanical contrivances, and the manifold latter-day developments and arts in which they are indispensable, form a chapter so vast that I have not attempted even the briefest summary.

Wheels for facilitating transit are therefore my theme, and no apology need be proffered for an account of what was one of the primitive inventions of mankind, and is of prominent importance to this day. There is a humanitarian as well as a scientific interest in this study of wheels. Throughout the ages, the use of wheels has played a crucial and ever-active part in the development of the means of intercommunication, now become so rapid and frequent as to form the ineradicable and predominating feature of our time. We know now how closely rapid intercommunication and civilisation are bound up together. Bearing this in mind, one need feel no compunction in drawing inferences as to the degree of civilisation of the ancient peoples from their wheels. The ancient Egyptians employed wheel vehicles for many purposes, and particularly for war, but the Israelites they held in

bondage had no chariots at that time. This stood them in good stead when crossing the Red Sea; the Israelites crossed safely on foot, but, according to Holy Writ, the wheels of the Egyptian chariots became (taking the marginal reading) bound so "that they drave heavily." This, which happened about 1490 B.C., is the earliest record I have found of wheel trouble, but for which the Israelites might never have reached the Promised Land.

Origin and Evolution of the Wheel.

The actual origin and inventor of the wheel are lost in the mists of antiquity. The use of it appears to have originated in the East and spread westwards. Doubtless the nomadic tribes would be among the first to discover the advantages of wheels. This may account for their widespread use at a very early date. The oldest Indian literature mentions wheels, showing their use as parts of vehicles as far back as 1700 B.C. This is about the date of the first reference to wheels in Holy Writ.

Those who seem most competent to judge, agree that the wheel took its origin from the cylindrical tree-trunks which were placed as rollers under a load. Probably the first vehicle was the sledge, the rollers being used when heavy masses had to be drawn. Rollers being in demand, and heavy ones being difficult to handle, it is likely that long ones were cut up to make small ones. The desirability of fixing these would soon become felt. Precisely how this was done we do not know, but conjecture suggests that the middle may have been grooved out to permit of a staple or pegs on the sledge engaging with the groove and preventing it running along or sideways. This groove may have come to extend the whole width of the sledge. A natural sequence would be to build this form up out of three parts —two disc-wheels and one axle, the axle being prevented by pegs from rolling away underneath the cart. Solid wheels were used by the less civilised nations of Asia Minor, and on the farm-carts of classic times. Virgil refers to solid wheels built up of three planks held together by an iron hoop, and this form is said to be still in use in Southern Italy and to make a loud creaking noise as it turns. Some of the old Chinese pictures show solid wheels with holes cut out, possibly for lightness, but more probably to admit a pole for skidding the wheel on a decline. This is an ancient method of braking, from which has arisen the phrase, "to put one's spoke into another man's wheel."

As late as thirty years ago bullock-carts were in use in Lisbon with only two such pegs to keep the axle in position. The body of the cart could be lifted right off the wheels, and even now solid wheels and axle are hewn in one piece out of tree-trunks and used for carts in the northern provinces of India. Solid wheels with iron axles are also used.

Splitting must have been a serious cause of trouble in ancient disc-wheels. Some that are still extant, dating from 1550 B.C., show bad splits and leathern thongs binding the parts together. Segments of tree-trunks would necessarily have a limited diameter, and though the large ones would prove better runners on rough roads they would be more likely to split. This may have led to planks being nailed together, some crosswise, and the survival of the fittest would account for their persistence. From this to radial planks cut parallel to the grain is not a long step, and from radial planks to spokes is a natural sequence.

The Wheel and Religion.

In India the wheel entered largely into the native rites of worship. Some of the religious writings contain an account of a mystic wheel, with a nave and tyre and a thousand spokes. The connection between the wheel and religion has been investigated by W. Simpson. The wheel was symbolic of the apparent rotation of the sun and stars, the worship of which led to the use of praying-wheels, circumambulation, processions, and other "circular" rites.

At this time, to speak of a man as being "like a wheel" was as complimentary as it now is uncomplimentary to call anyone a *roué*. It is interesting to note, in passing, that this degeneration probably arises out of the connection between vice and the use of the wheel as an instrument of torture.

It appears that India was not the only place where the wheel was held in veneration. M. Gadioz has discovered that there was a deity whose most prominent symbol was the wheel. Most of the figures of this god of the wheel are found upon French soil. The oldest represent Saturn holding up an eight-spoked wheel in the left hand; many show a six-spoked wheel. These date back to Teutonic times. Later the Gaulish Wheel-God became Romanised, and the figures take the form of a Roman holding a ten-spoked wheel. Altars have been found with an eight-spoked wheel carved on them. The Gauls of antiquity wore small wheels as amulets, some of which are to be seen in the British Museum, and are of bronze and about the size of a penny.

Other wheel amulets were of gold, silver, lead, and even terra-cotta. From the number that have been found in rivers and at fords it has been inferred that they were offerings to pacify the River-God and procure a safe crossing. Most of these have four spokes and a heavy rim.

The form of punishment known as breaking on the wheel is a survival of sacrificing to the Sun-God or Wheel-God, just as hanging is a survival of sacrificing to the Wind-God, and the nstitution of this horrible custom in France is doubtless connected with their greater familiarity with the Wheel-God. In 1534 this was the treatment reserved for highway robbers:—The condemned was first placed on a sort of St. Andrew's Cross with his limbs hanging between the four pieces of wood. The executioner then broke his arms, fore-arms, thighs, legs, and chest. The victim was then attached to the rim of a small coach-wheel suspended in the air by a thick post, the broken arms and legs were tied together behind his back and the wheel rotated.

Chariot Wheels.

We will now consider some of the early wheels a little more closely. The use of these for chariots led to a very advanced development even at a very early date.

The invention of chariots is ascribed by some to Erichthonius, son of Hephaestus and King of Athens, who flourished about 1460 B.C.; by others to the priest Trochilus or his son, Triptolemus. Homer described Telemachus as travelling from Pylos to Sparta in a chariot provided for him by Nestor:—

> The rage of thirst and hunger now suppress'd,
> The monarch turns him to his royal guest;
> And for the promis'd journey bids prepare,
> The smooth-haired horses, and the rapid car.

Probably, however, chariots had long before this been in use among the Egyptians. In Holy Writ we find two references to Egyptian chariots in use about 1715–1705 B.C. Chariots were, with very few exceptions, two-wheeled vehicles.

Design of Early Wheels.

Egyptian Wheels.—The Egyptian chariots, as shown by their sculptures, were easily carried by one man, and were, therefore, quite light. It is worth noticing, too, that the wheels were placed as far back as possible. In this position part of the load is borne by the horses. Since the chariot was so light this design could scarcely have been chosen to save them; the object must have been to lessen the load on the wheels and to reduce the shock transmitted to the rider.

The first slide shows a wheel found in the tomb of the Egyptian Tuiyu (1583 B.C.), now in the Cairo Museum. Round the rim is placed a leather tyre, so that the mighty dead should be protected against the shocks of the road when travelling during his second time on earth.

The Egyptian war chariots generally have six spokes, a few have eight, and others twelve; their private cars had only four. The spokes were usually round. The felloes were strengthened at the joints with bronze or brass bands, and the rim was a metal hoop. An Egyptian wheel has been found having a wooden tyre in six butt-ended segments, and a felloe in six segments lapped at their ends. The rim segments have four slots near the felloe, and bands of raw hide are passed through these slots to bind the rim and felloe segments together. The spokes are round and tapering near the nave, and square and tapering near the rim. They are provided with dowels at each end and a slot near the nave end, probably for a metal band. The diameter of this wheel is 3 feet 1 inch. In Egyptian wheels the axle-trees do not rotate, and the wheels are kept on by small linch-pins.

One of the Egyptian paintings in the British Museum shows a wheel with a nave in one piece and sockets for the six round spokes. At the end of each spoke is a T-piece, which forms a socket both for the spokes and for the segments of the tyre. There is also an Egyptian wheel in the British Museum. This is of wood, disc-shaped, flat on both sides and probably off a cart or truck used about 1550 B.C. It is still in excellent preservation and is about 2 feet in diameter, about 7 inches thick, with a cylindrical hole at the centre about 7 inches in diameter. It appears to have been cut from a solid tree-trunk.

Assyrian Wheels.—The Assyrian sculptures show three forms of wheel:—(1) Four-spoked, with heavy rims and tyres for heavy carriages. Some of the hand-carts shown in the sculptures have four very broad spokes, which look like boards. (2) Eight-spoked, with three concentric rings in the rim, the outermost being the tyre proper, and spokes fitting into sockets at the nave. These were for chariots. (3) Wheels with nail tyres. This slide shows the chariot of an Assyrian king, Assurbanipal (date 668–626 B.C.). Judging from the height of the horses and size of the men, these wheels must be from 5 to 6 feet in diameter. Note the tapering spokes, heavy-studded tyre, and four gaiters to keep the tyre on the rim. Occasionally we come across Assyrian wheels with twelve spokes. This slide shows a warrior's chariot with captives

in front. The wheel is not more than 3 feet 6 inches to 4 feet in diameter.

The next slide shows the hunting chariot of the Assyrian king, Assurnasirpal. These wheels are much smaller than the last, probably not more than 2 feet in diameter. You will note how very massive the tyre parts are in these wheels. The six spokes are comparatively slender. This suggests that they were either made of metal or that they presented their edges towards the outside. The tyres are generally built up of four, five, or six segments, the joints being sometimes at the spokes and sometimes between.

Persian Wheels.—The Persian relievos also show an advanced development. This slide shows a wheel with twelve ornamental spokes fitting into a rim carrying a studded tyre. These studs were doubtless intended to keep the metal tyre on the wooden felloe, but their number suggests strongly that, even in those very early times, they appreciated the need for some non-skid device.

Among the discoveries in South Germany are some iron tyres, all that remains of the chariot buried with some dead warrior. These tyres are about 40 inches in diameter, and are covered with radial spikes on the inside. On the outside are still left the overlapping scale-like heads of nails, just like the Assyrian and Persian tyres we have seen on the screen.

Cyrus, King of Persia about 560 B.C., made several improvements in chariots and chariot-wheels. We are told that he noticed how easily the wheels broke and built them stronger. He lengthened the axle to give chariots more rigidity, and at each axle end of the war-chariots he fixed a horizontal scythe, and underneath the chariot other scythes with their points turned towards earth.

Grecian Wheels.—The Greeks preferred wheels with four spokes. Some Greek vases (800–500 B.C.) show racing-chariots with wheels having four flat spokes. This slide is from a terra-cotta relief, and shows Paris abducting Helen. You will note how very crude this wheel is compared with the approximately contemporaneous Assyrian and Persian examples. The flat side of some Grecian spokes is wider at the nave than at the rim and parallel to the axle. Strengthening pieces appear always to be used at the junction of the rim and spokes, and the tyres are in segments—generally four or more—of flexible wood kept in place by an outer iron tyre. This slide shows a racing-chariot with eight spokes. Like the former, this Grecian wheel is quite small, probably not more than 20 inches in diameter. The slide shows the reins tied round the body of the charioteer, which, as you may remember, was their custom. The metæ are the conical posts which marked the turning-point; the spina is the low wall (or spine) running down the middle of the racecourse and round which the competitors had to drive. One vase (about 700 B.C.) shows a racing-chariot with two spokes, and two bars at right angles to these from one side of the rim to the other, but not passing through the nave. These wheels were made to rotate on the axle. The nave had an external ring of iron into which the spokes fitted, and a flat ring supported by a linch-pin prevented the wheel from coming off. Their diameter was for the most part under 30 inches, and the two wheels were nearly 7 feet apart.

Materials Used in Ancient Wheels.

The early Egyptian carriage-wheels were made of wood, and some of these are still in existence. Their sculptures show their methods of bending the felloes and rims, spoke-making and wheel-building. The spokes were shaved to make them round and smooth. The Egyptians knew how to produce iron as far back as 3733 B.C., but it was among the Assyrians that this metal was most freely used for the production of tools, weapons, and ornaments, and the Egyptians probably learned many of the uses of iron from them. We have already seen how the Assyrians applied their skill in metal-working to wheel-making, and doubtless their progress in this direction is closely connected with their military success.

According to Holy Writ, the wheels of Solomon's laver carriages (about 1000 B.C.) were bronze. We read :—"Their axle-trees and their naves and their felloes and their spokes were all molten." At the time of Judah (about 1440 B.C.) we read of the dwellers in the valleys of Palestine having chariots of iron. This probably refers to forged iron; cast-iron was probably not known till after the time of Homer (about 900 B.C.). The first Grecian wheels were made of oak. This slide shows the wheel of a funeral-car, which appears to be made entirely of wood, except for the tyre. The later Grecian wheels were made entirely of bronze. The next slide shows a bronze two-horse chariot. Homer speaks with enthusiasm of copper tyres (Iliad 5, 722 *et seq.*) :—

> Quickly Hebe fixed on the chariot the rounded wheels of copper, eight spoked, around an iron axle; their felloes were indeed of gold, imperishable, but around tyres of copper were firmly fitted, a wonder to behold.

Whether this was a detachable spare wheel that the Goddess of Youth was fitting to the chariot we are not told, but it is interesting to note how gold felloes pale into insignificance beside copper tyres that did not easily come off.

There are some antique bronze chariot-wheels still in existence at Toulouse. These are 54 centimetres in diameter, and have naves 40 centimetres long and 7 centimetres in diameter. The spokes are five in number, and there are deep recesses in the felloes to take the tyres. The rivets used for fastening on the wooden tyres can still be seen in the felloes.

Of early British wheels I have no examples to show. Cæsar, you may remember, found our ancestors possessed of war-chariots which they managed with great skill, implying a long previous acquaintance with the use and manufacture of wheels.

Ancient Wheels—General Considerations.

Before leaving these ancient wheels it is, perhaps, worth pausing a moment to consider their main features from one or two present-day points of view—*e.g.*, strength, serviceability, and appearance. In those times torque would only be applied to a wheel in its plane when occasion arose to put the shoulder to the wheel. They were not built to transmit torque, so when the Egyptian wheels sank in the sand of the Red Sea they gave trouble. The same must have happened in many other cases. Every time a car or chariot curved to the right or left a thrust on the rim would be developed perpendicular to the plane of the wheel, its magnitude depending on the weight, speed, and flexibility of the car, the radius of the curve and the character of the ground. The tendency of this would be to break the spokes near the nave. In overcoming this there are two paths open to the designer, one is to dish the wheel, the other to strengthen the rim—the former is the modern way, the latter was the method adopted by the ancients. The Greeks, as we have already noticed, provided strength to resist side-thrusts by sometimes employing spokes wider near the nave and with their flat side parallel to the axle. This was also the method employed for building one of the London Omnibus Company's wheels which came under my notice a few years ago.

With regard to serviceability, it is probable that these ancient wheels would work loose where the spokes enter the felloe and nave. This would lead to loud creaking and groaning, and probably partly explains why we read of the mother of Sisera listening for the noise of his chariot-wheels and not for the sound of his horses' hoofs. No doubt the sockets employed in the more recent of the ancient wheels served to strengthen the joints and minimise the noise.

With regard to appearance, even in very early times they preferred wheels with more spokes (eight and twelve) for war and state purposes. Where the wealth of Solomon made it possible, bronze wheels were preferred, and among the æsthetic Greeks the all-bronze wheel found considerable favour.

The foregoing account, incomplete though it is, will be sufficient to show that there was considerable variation in the design and materials employed by the ancients in wheel-making. Even the wheels of the same country differed considerably among themselves. As early as 500 B.C., wheels had reached a very advanced stage of development even in Europe, due partly to their use in war, partly to the sports of the Stadium, and partly to the rough roads and tracks they had to traverse.

Modern Wheels.

The Suspension Wheel.—We will now pass on to the next stage in wheel development, which dates from the use of bicycles. During this gap of about 2,500 years the only changes of any importance were the dishing of wheels to resist lateral stresses due to ruts and rounding corners, and arranging the spokes on two cones instead of one. This last was done as early as 1828, and is still used at Woolwich Arsenal in building ambulance-waggon wheels. Strange though it may appear, wheels were not used generally for facilitating transit in Britain till comparatively recent times. The very first carriage was made for Queen Elizabeth in 1568; the first that plied for hire in London were in 1625, and the first stage-coaches were in 1659. Broadly speaking, all the early wheels were compression wheels with radial spokes. The introduction of the suspension wheel for bicycles marked a great advance in the shock-absorbing powers of wheels. The first bicycle wheels were compression wheels, and had wooden spokes and rim with an iron tyre. The wheels were just ordinary light carriage wheels. The curved member connecting the back axle to the top of the front wheel is not altogether unlike that used in the chariots we have been looking at. Later bicycle wheels had radial-wire spokes which, being in tension, kept the rim in position. In the older wheels the rim was normally in tension, and the spokes and hub in compression. In a suspension wheel the spokes

and hub are in extension, while the rim is in compression. It is a common, though not unnatural error to suppose that the spokes of a modern bicycle wheel are sometimes in compression. As a matter of fact, they are always in tension, even those between the hub and the ground, when a heavy rider is in the saddle.

A suspension wheel has very little in common with a suspension bridge. If a number of contiguous canal bridges were built in a circle right round the earth, and the earth cored out, the resulting structure would much resemble a large wooden wheel, in which the compression due to the shrunk-on rim was replaced by that due to gravity. A like series of suspension bridges would, however, be quite unlike a wire wheel. In the latter there are no members whatever in compression between the rim and the hub, and its structure is more nearly related to that of a trellis which can be prevented from falling in in one direction by compression at right angles.

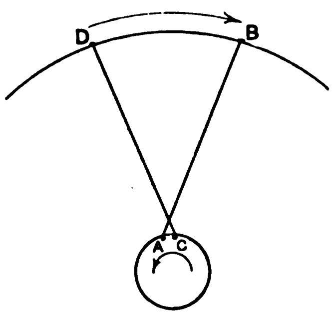


FIG. 1.

Fig. 1 represents one element of a wire wheel. If tension be applied to the spokes, the rim and hub would move towards one another were it not for the effect of the other segments; the resistance to the compression forces in the rim, and to the bursting stress in the hub shell prevents this movement. When compression is applied between the bottom of the rim and the hub-centre of such a wheel, the tension of each spoke will, if the rim is inflexible, decrease proportionately to the cosine of the angle between the spoke, or, rather, the projection of the spoke in the plane of the wheel, and the direction of compression. When the cosine becomes negative, as when the spoke is above its horizontal position, the decrease becomes, of course, an increase, having its maximum for spokes on the upper part of the wheel pointing in the direction of the compression. Obviously the spoke tension should never fall to zero nor rise above the elastic limit, and these limits help to regulate the choice of the initial spoke tension.

The Tangent-Spoke Wheel.—The tangent-spoke wheel, in which the spokes are tangent to a circle having its centre at the axle and are not normal to the rim, probably owes its origin to the curved arms used in driving pulleys and fly-wheels for transmitting considerable torque. This slide shows a bicycle of the transition stage—most of its spokes are radial—or nearly so; the rest are tangent to a circle of large diameter. The next slide shows an early tangent-spoke bicycle wheel, in which all the spokes are tangent to the same circle. Both ancient and modern *radial* spoke wheels are capable of transmitting a certain amount of torque, but the amount is limited, and depends not only on the bending strength of the spoke, but on the rigidity of its attachment to both rim and hub. Since no material has an infinite elasticity, it follows that however thick the spokes may be there must be a certain amount of twist of the hub (in the plane of the wheel) relatively to the rim, or no drive can be transmitted. When the torque is considerable—as in a motor-car rear wheel—the actual twist sooner or later rises above that corresponding to the elastic limit at some or all of the spoke attachments, and this leads to gradual loss of rigidity and to creaking, and, in some cases, even to charring owing to rubbing. In a radial-spoke bicycle wheel subjected to a torque in its plane, the hub must rotate relatively to the rim until the spokes are tangent to a small circle. If the average tension on the N spokes is t, when transmitting the torque T the tangent circle will have a radius—

$$r = \frac{T}{Nt} \text{ approx.}$$

Applying this to a bicycle wheel with fifty spokes, and assuming the pull in the chain to be 300 lbs. (which is about that due to a vigorous jerk), the chain ring to be 3 inches diameter and the hub flange 1¾ inches diameter, if the average final spoke tension be 80 lbs., it is easy to show that the hub will twist $7{\cdot}35^{\circ}$ relatively to the rim.

In a tangent-spoke wheel the hub must also turn relatively to the rim, but the angular movement is far less. In this case torque has the effect of increasing the tension on half the spokes and decreasing it on the other half. Reverting to Fig. 1, if the initial tension on $A\ B$ and $C\ D$ be t and the added and subtracted tension be p, the torque due to—

$A\ B$ will be $(t + p)\ r$, and to
$C\ D$ will be $(t - p)\ r$.

The difference of these is the resultant torque due to this element—

$$\therefore \text{ Total torque} = \frac{N}{2} \times (tr + pr - tr + pr)$$

$$\therefore T = N\, p\, r.$$

Which is independent of the initial tension t provided $(t - p)$ is a positive quantity.

If the tangent circle be of the same diameter as the flange in the previous case, it is easy to show that, for fifteen-gauge spokes elasticity 10,000 tons per square inch, the twist of the hub for the same push as before will be $0 \cdot 11°$, or about one-seventieth that with radial spokes. This greater rigidity in torque transmission places the tangent-spoke suspension wheel far ahead of both radial compression and radial tension wheels. It has long been universally used for bicycles and motor-bicycles, and is now enjoying unrivalled popularity in its application to motor-cars.

The radial wheel has to be subjected to great radial tension or compression in order to impart the necessary torque rigidity. In the tangent wheel the necessary torque rigidity can be attained without imparting excessive radial rigidity. As a result of this the tangent suspension wheel can be made capable of absorbing shock. A comparison of a suspension wheel with a section of a tyre will bring this out more clearly.

Suspension Wheel and Tyre Segment Compared.

The deformation of a tyre by load is resisted because the radially-acting air pressure puts the tube and cover in considerable tension. The rim of a suspension wheel is the reciprocal of this, being in compression due to the radial components of the spoke tension. The rim flattens like a tyre under load or shock, the radial tension in the one case acts like the air pressure in the other; the greater the tension the less the rim flattens, and the less the tension the "softer" is the wheel.

Wheel-building is the counterpart of tyre-inflating, and the art produces its best when sufficient tension to produce torque rigidity is combined with conditions that develop in the wheel a maximum cushioning effect. Such a wheel, by co-operating in the duties of the tyre, lengthens its life and lessens its liability to wear, cuts, and punctures. To obtain maximum cushioning from a wheel of this type, moderate spoke tension needs to be combined with a flexible and resilient rim and thin spokes. This in its turn implies not only careful choice of materials, but appropriate design to neutralise the reduction of resistance to torque perpendicular to the plane of the wheel entailed by lightening the rim. Both the wheels of antiquity, modern artillery wheels, and wheels for motor-cars, owe much of their lateral strength to the high moment of inertia of their heavy wooden felloes, the disadvantage of which is their inflexibility and consequent inability to absorb shock. The Rudge-Whitworth wire wheel for motor-cars (Fig. 2) is the first wheel in which these requirements were adequately met. This is done by making the outside spokes, that are much dished, enter the rim near its edges and not at its centre, as was formerly considered correct. In this way members are provided to oppose the twisting of the rim due to sideways shearing of the tyre when rounding corners.

It is only fair to add that this method of spoking has the effect of localising the bending stresses, due to the pull of the tyre bead, in the edge of the rim. This is met by strengthening the rim bead, which at the same time strengthens the whole wheel very considerably.

There is another point of similarity between the wire wheel and a tyre segment. If the radial compression on tyre walls gradually decreases owing to air escaping from the stressed condition, the flexed part of the tyre will be increased, and a point arrives at which this has to be neutralised by inflating. Similarly, if the spoke tension of the wire wheel should fall the flattening of the rim would increase, and might even reduce the spoke tension to zero.

Fortunately, solids are more easy to manage than gases, and by employing spokes of high elastic limit, and by cold working the metal of the hub shell round the spoke heads, and of the rim round the nipple holes by hammering and bulging (coupled, of course, with proper design and materials), the vibration elastic limit above which permanent escape and loss of tension would occur, is made so high that after a slight initial bedding the ordinary stresses are insufficient to "soften" the wheel. In any event, the spoke tension can be adjusted readily. It is not to be supposed that even a wheel of this advanced type is capable of absorbing as much shock as a tyre. The air pressure in the inner tube of a motor tyre ranges usually from about 60 to 90 lbs. per square inch, but the corresponding normal pressure on a Rudge-Whitworth wire wheel rim ranges from about 150 to 200 lbs. per square inch. This, combined with the fact that the rim is not nearly so flexible as a tyre cover, accounts for its inferiority to the tyre as a shock absorber, though the much larger diameter of the wheel operates in the other direction. Large

diameter wheels—like large section covers—are, *ceteris paribus*, better shock absorbers than small ones. The superiority of this type of wire wheel as a shock absorber, compared with compression wheels with radial wood spokes, is a matter of actual experience as well as of conjecture, and is noticed in their more constant contact with the ground under similar conditions of use.

spokes transmitted the drive. In the present Rudge-Whitworth wire wheels, to prevent the stresses rising too high when rounding corners or when skidding, the wheels are dished and the outside spokes are relieved of the whole or greater part of their share in transmitting drive. This is done in some types by making the hub of much larger diameter at the end near the car than at the other end. As a result of this the

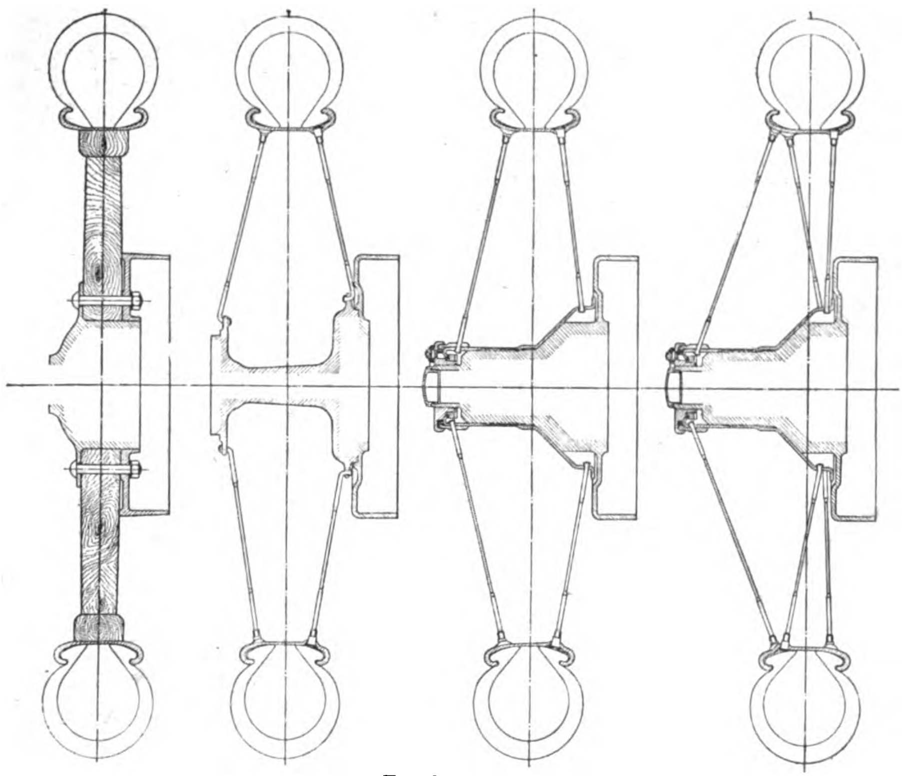


FIG. 2.

Fixed wood wheel. Fixed symmetrical wire wheel. Rudge-Whitworth patent detachable wire wheel, patent dished construction, double-spoked. Rudge-Whitworth patent detachable wire wheel, patent triple-spoked construction. Regd. No. 541916.

displacement of the inside spoke heads under torque is greater than the displacement of the outside spoke heads, the ratio of the displacement in the direction of the spokes (and therefore of the added tension) being the ratio of the diameters of the circles to which the spokes are tangent. In other types the end of the hub to which the outside spokes are attached is revoluble, so no torque is transmitted by them and their whole strength is reserved for resisting side-thrusts.

Another departure from symmetry which secures greater strength for the inside or driving spoke cone is the employment of 50 per cent.

EVOLUTION OF THE MOTOR-CAR WIRE WHEEL.

The first wire wheels to be used for motor-cars were bi-laterally symmetrical like the front wheel of a bicycle. The spokes were headed and bent near the head through 90° (see Fig. 2). The holes in the hub flanges were drilled parallel to the axle, and the spokes threaded through these holes were attached to the rim by nipples screwed on to the other end of the spoke. But, as in living structures, so in engineering constructions, evolution brings gradual morphological differentiation of structure and further division of labour. In the early bi-laterally symmetrical wire wheels both inside and outside

more spokes inside than outside. In the hub shells the spoke holes are not drilled parallel to the axle, but perpendicular to it. This enables spokes bent through a small angle to be used; for instance, the inside spokes that transmit the drive are only bent through 45°, and this, coupled with a special way of producing the bend and careful scrutiny in the firms' laboratory, has enabled the strength at the bend to be increased from about 60 per cent. (with the 90° bend) to over 90 per cent. that of the body of the spoke. The outside spokes are bent through less than 45°, so the strength at the bend is still less impaired. Another improvement is the addition of another cone of spokes, making three in all, so that the drive is transmitted to both sides of the rim. The same device enables the point of contact with the ground to be more nearly under the bearing or steering knuckle (see Fig. 2).

I will next show you a diagram (Fig. 3) illustrating the fluctuations of spoke tension (or compression in a compression wheel) under some of the conditions of use, assuming that the rim is *not* flexible. When the wheel is jacked up, revolving does not appreciably alter the spoke tension, and it does not vary with time, so is represented by a horizontal line. When the car is in steady motion and free-wheeling the tension on each spoke will increase and decrease, the values following a cosine curve (as already explained), the X axis of which should be below the minimum points. The zig-zag illustrates the effect of a shock due to the wheel leaving the ground and falling back suddenly to its former condition. The dotted line shows the instantaneous condition of a spoke diametrically opposite.

In the next we see the variations in tension of the spokes of a driving wheel travelling straight; and the next shows the variations when the wheel is being driven round a corner. It is important to notice that the effect of the same shock is very different in the different cases, and depends on the instantaneous value of the spoke tension as well as on the position of the spoke in the wheel. The variation set up in a wood wheel will follow the diagrams pretty closely, but actual experiments with wire wheels show that the increment of tension due to load, torque, and load and torque combined, is not nearly so great as those diagrams indicate.

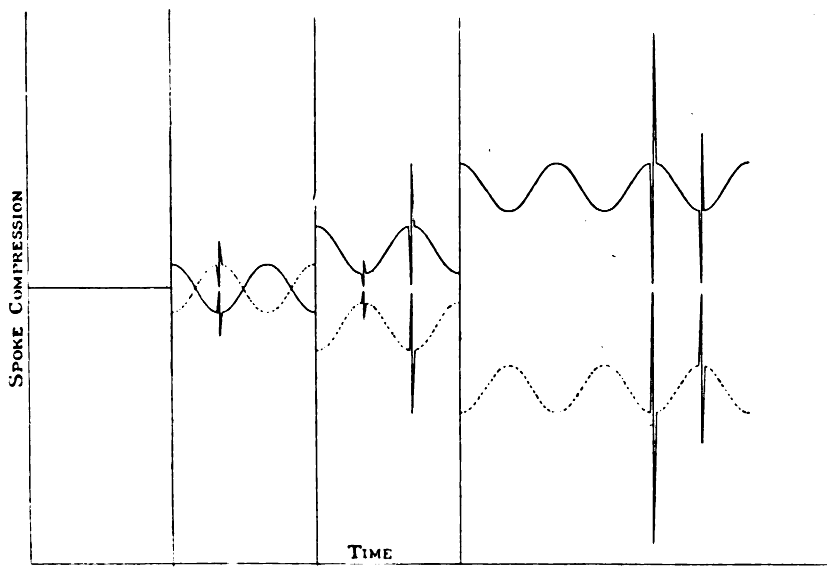


Fig. 3.

Experiments with Wire Wheels.

Fig. 4 shows a polar diagram of the tension on the spokes of a Rudge-Whitworth detachable wheel fitted with a tyre sustaining a load of one ton. About one-quarter of the spokes have their tension relieved, but the others experience nothing like the same increase, and it is distributed fairly evenly all round.

To test the effect of combined load and torque the pull was applied to a dummy tyre made of iron, so that its line of action did not pass through the centre of the wheel. By varying the distance between the wheel centre and the line of pull the ratio $\frac{\text{load}}{\text{torque}}$ could be varied at will. In this way tests imitating all sorts of

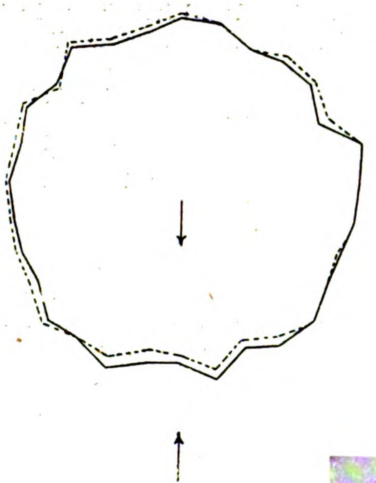


FIG. 4.

conditions of road surface, car load, and horse-power engine have been carried out.

Fig. 5 shows a polar diagram for a wheel having the same number of outside and inside spokes, the outside spokes of which transmit their pull to the hub and not to a revoluble ring. The outer dotted line indicates the initial tension on the inside spokes, the inner that on the outside ones. The dots show the effect on the tension of the combined load and torque. In this test the inner hub, hub-shell nipples, and rim are all tested, and the results demonstrate beyond controversion the enormous strength of these wheels for forces and couples

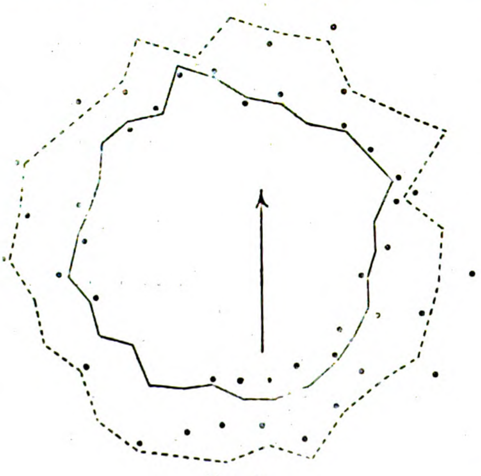


FIG. 5.

in the plane of the wheel. The point to which I would particularly call attention is the great advantage of a flexible rim which, as these results show, quite obviates the high tensions or compressions which would otherwise obtain, and which would prove so destructive every time the wheel was jerked off the ground.

In addition to determining the effect of load and torque, separately and combined, we have subjected both wood and wire wheels to a side-pull applied at the rim or to a dummy tyre. Fig. 6 shows a Denison testing-machine adapted to imitate the stresses set up in rounding a sharp corner at very high speed or in a bad side-slip. The results of some of these tests will be seen

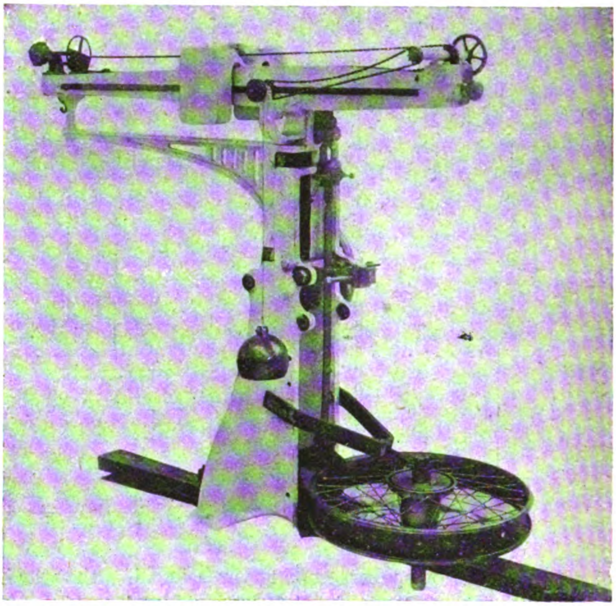


FIG. 6.

in Fig. 7. In nearly every instance the deflection of the wood wheel for the same pull is greater, and in every case the wood wheel sustained permanent damage at a lower pull than in the wire wheel. The same applies to the sheet-steel wheels. The arrangement of the spokes in the Rudge-Whitworth wire wheel has been the subject of careful design and experiment. Fig. 8 shows the results of some of these experiments, and makes it clear that the strength attained, even with precisely similar rims, hubs and spoke material, depends greatly on the design selected. These tests have given valuable data as to the best designs and materials for the rims, spokes, and hub shells. It does not follow, however, that designs and materials proved suitable for withstanding a steady force are also suitable for

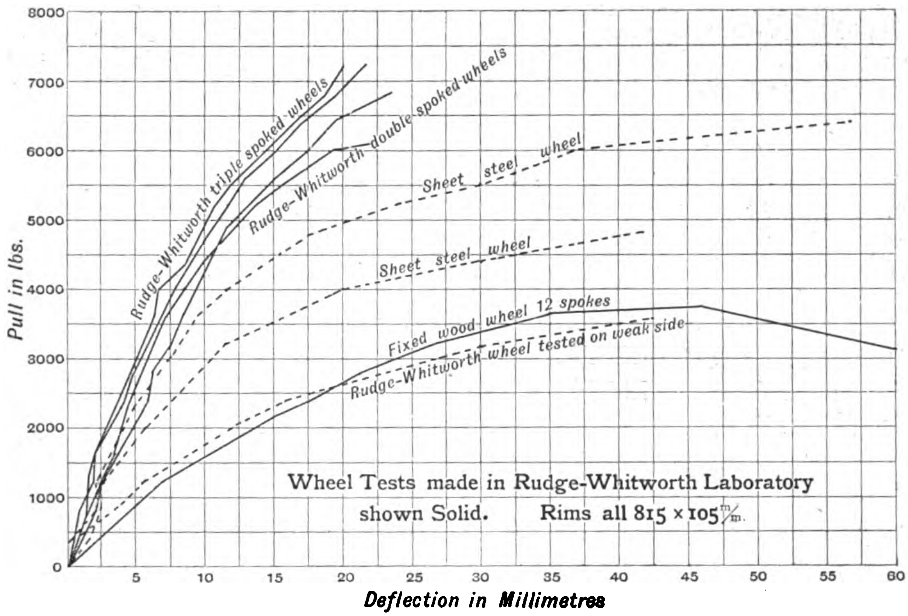


FIG. 7.

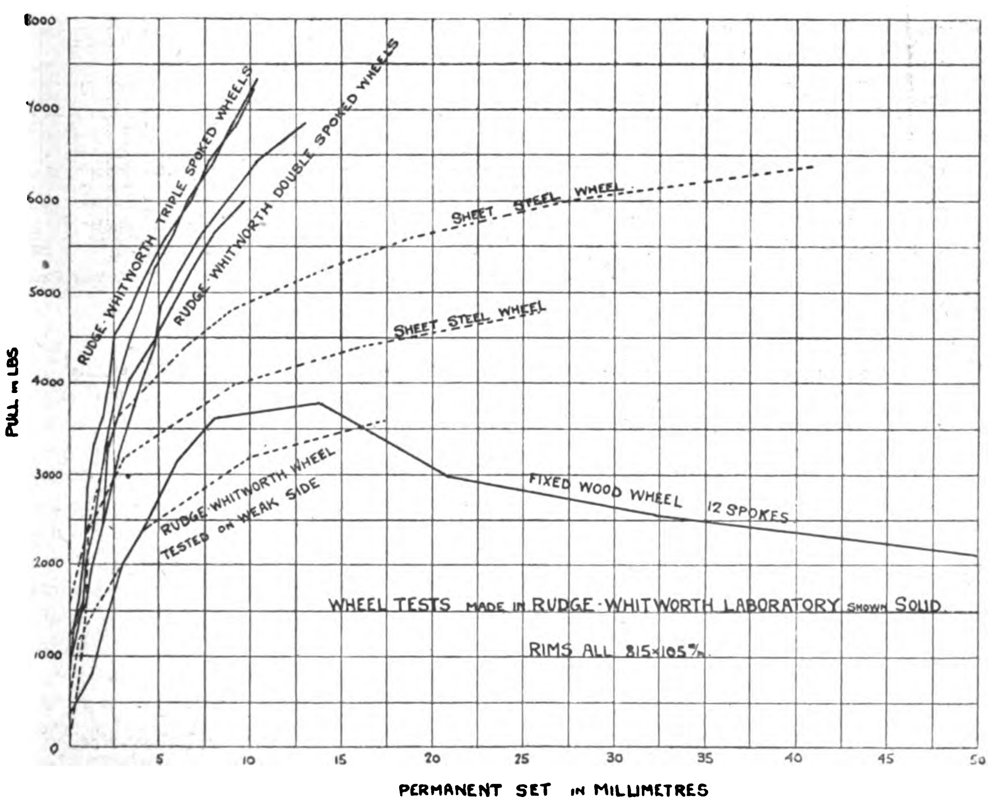
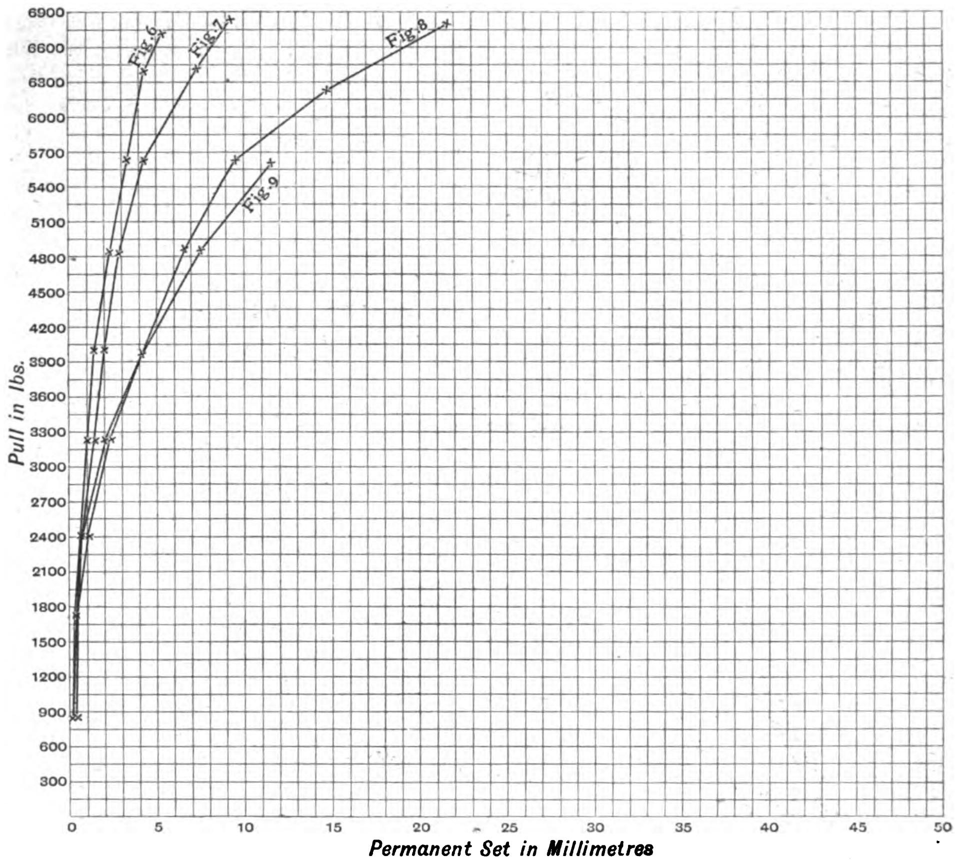


FIG. 7 (continued).

impulsive forces, so the various types of wheel have been investigated under impact.

The next slide shows the impact pendulum ready to be released against the top of the



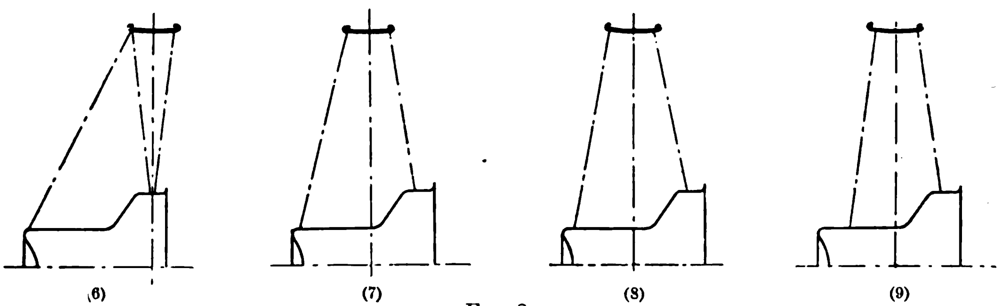


FIG. 8.

rim of the tyred wheel. The length of the pendulum is about 12 feet and the bob weighs nearly a quarter of a ton. In some tests increasing blows were applied to the same part of the wheel, in others a moderate constant blow —*e.g.*, 200 foot-lbs.—was applied at successive points on the rim eleven-thirtieths of the whole circumference apart. Fig. 9 shows characteristic diagrams for wood, wire and sheet-steel wheels subjected to increasing blows at the same place; and Fig. 10 shows the results of testing wood and wire wheels with similar blows, the wheel

being turned eleven-thirtieths of the way round after each blow.

The question will probably suggest itself as to whether a motor-car wheel is ever called upon to stand side-thrusts and blows as great as those represented by the upper part of Figs. 7 and 9. The magnitude of the stress depends in every case, not entirely, but primarily, on the force that the ground can exert on the wheel. For instance, the forces that turn a car round a corner reside in the ground. It is quite a mistake to suppose that the driver at the steering-wheel really steers the car; the path followed may be *indicated* by the steerer, but it is *dictated* by the ground. The most the driver can do is to turn the wheels into such a position that, if the ground permits, the forces developed under and near the wheels will alter the direction of the car to the desired extent.

The stresses set up when rounding corners without skidding have been very fully investigated by J. V. Pugh (*Autocar*, 1906, pages 910 and 948). When travelling at twenty miles per hour round a curve 30 feet radius, the side-thrust on an outside wheel, at the tyre, may be as much as 1¼ times the load on the wheel when travelling straight. When skidding, the side-thrust may be considerable, not only when stopped by a curb-stone, but also when the side-slipping wheels are arrested by a dry, sandy, or rough part of the road.

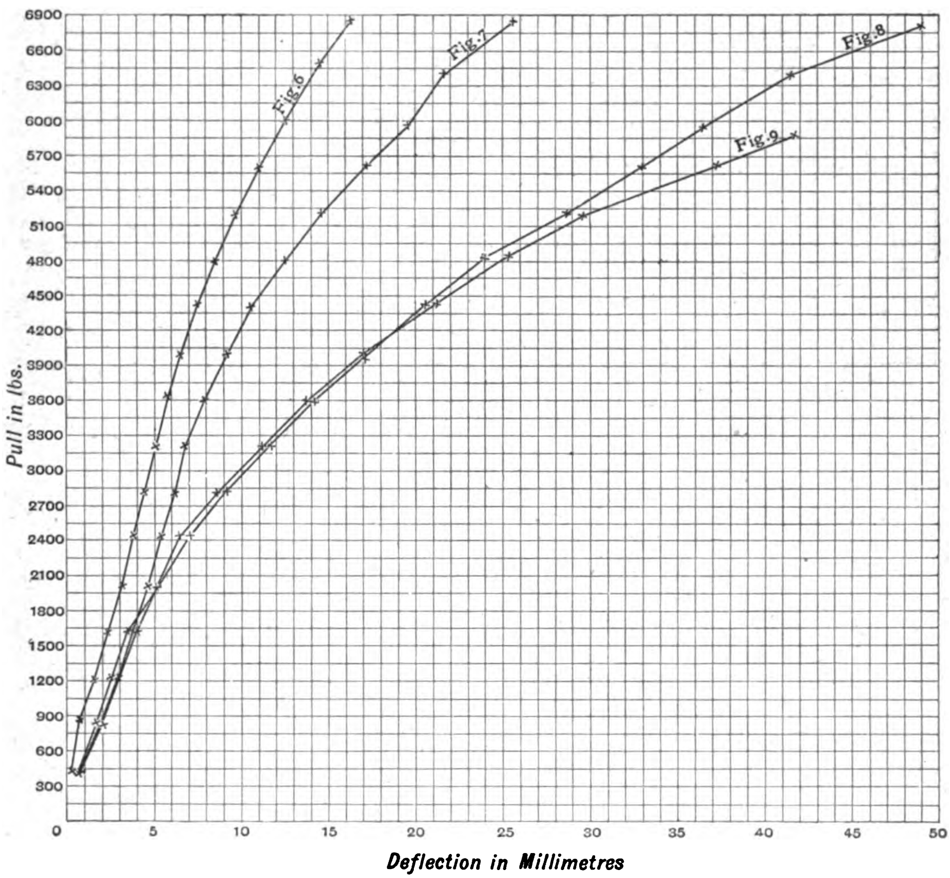


FIG. 8 (*continued*).

If the rear wheels of a car weighing one ton skid sideways at a corner, and are brought to rest by the outer wheel running on to a dry, rough, or sloping part of the road, and if two-thirds of the load is borne by the rear wheels, and they attain a sideways velocity of five miles per hour, and stop after sliding three inches beyond the slippery part, then, taking moments

about the front wheels, the retarding force is

$$\frac{2\,W}{3} \cdot \frac{v^2}{2\,gs} = \frac{2}{3} \cdot \frac{2240 \times 53{\cdot}8}{64 \times {\cdot}25}$$

= 5020 lbs. approx. on one wheel.

On a smooth surface, even if dry, the ground would not exert so great a force on the tyre,

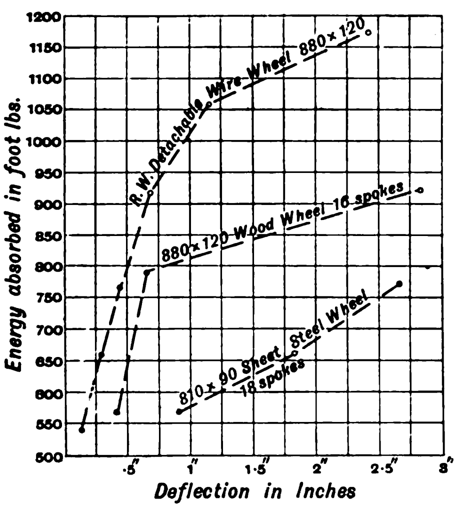


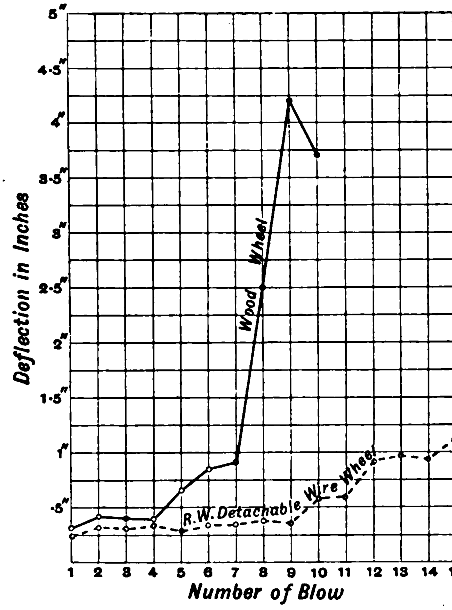
FIG. 9.

but when rough and sloping, even greater forces can be exerted.

Having now shown the superiority of wire wheels as shock absorbers, under load and torque, under side torque driving and shock in a direction vertical to the plane of the wheel, I will give a brief outline of the tests that are regularly carried out in the Rudge-Whitworth research laboratories to maintain the standard of excellence. It will, perhaps, be convenient to start with the hub where the torque is applied, and proceed *via* the hub shell, spoke heads, spokes, nipples, and rim to the tyre.

Inner Hubs.—The inner hub, which is of steel, is keyed on to the axle and has a series of keys which engage with similar slots milled inside the hub shell (Fig. 11). The material is analysed; its tensile strength, elongation, and contraction determined; and, as its main duty is to resist shear and transmit torque, test pieces are clamped in a vice and struck by an impact pendulum. From the sectional area of the piece, and the difference between the arc traversed after impact and the arc when there is no test piece in the vice, the energy absorbed per square inch can be calculated. The results are reported diagrammatically.

Definite limits have been arrived at for tensile strength, elongation, and impact resistance, above which all samples must be before acceptance. The strength of the threaded end is important, for it is a lock-nut screwed on to this that keeps the wheel on the car. The strength of the hub ends is regularly "proofed" by screwing the hub to be tested home into a



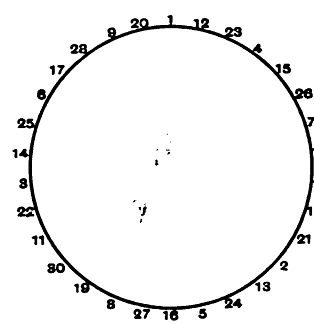


FIG. 10.

fixed lock-nut and applying a very considerable torque graded to suit the size of the hub, and well up to the maximum ever likely to be applied.

Hub Shells.—These are drawn from sheet steel, and some types are all in one piece. About fourteen drawing operations, each followed by careful annealing, are required. Quite apart from the stresses the hub is subject to in use, this mode of manufacture itself exacts a very

special quality of steel, and when it is remembered that a moderately-high elastic limit is required in the finished shell to resist the bursting stresses and the pull of the spokes, and that high elastic limit means greater internal stress and the formation of more brittle amorphous constituent during a given draw, it will be understood why the problem of successful manufacture was only solved after a long series of experiments on different steels, followed by the very closest supervision to maintain the uniformity of the steels selected.

Every consignment is analysed and tested for tensile strength, yield point, elongation, contraction, and resistance to impact, not only as received, but after heating under conditions as to time and temperature similar to those obtaining during an annealing operation.

Every consignment is also microscopically examined for flaws, manganese sulphide, size of crystal grains, form of carbide, etc. As would be expected, the behaviour in the drawing press is closely related to the elongation and contraction. Much depends also on the distribution of the pearlite and granules of cementite. One with a core rich in pearlite, but with decarbonised surfaces, may give much the same analysis as a steel with granules of cementite uniformly distributed throughout the ferrite, but the results in the press are very different. All reports on steels are typed on squared paper, and include a diagram (Fig. 12) embodying, as far as possible, all the experimental results that affect the mechanical properties. For instance, *A C* represents the tensile strength and *A Y* the yield point in pounds per square inch of a sample of motor hub-shell steel, *A B* its breaking elongation, and *A F* its contraction per cent. The area, *A B C*, represents in diagrammatic form the energy required to break one square inch of the steel by tension. Likewise, the area *A B E F* represents the ductility of the steel. *D B* is obtained by dividing the energy in inch pounds per square inch absorbed in breaking by impact, by half the breaking elongation, so *A B D* represents the energy per square inch required to break a test piece 1 inch by 1 inch. The corresponding triangles, etc., on the left, refer to the steel after annealing.

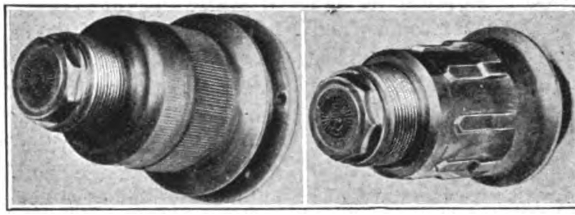


FIG. 11.

The rectangular areas, marked *C*, *P*, and *F* are calculated from the results of analysis, using the formulæ suggested by Campbell (*Journal of the Iron and Steel Institute*, 1904, No. 2, page 21), modified to suit this class of steel. The area *C* represents the part of the tensile strength contributed by the carbon (or more accurately by the carbides and their distribution), and that marked

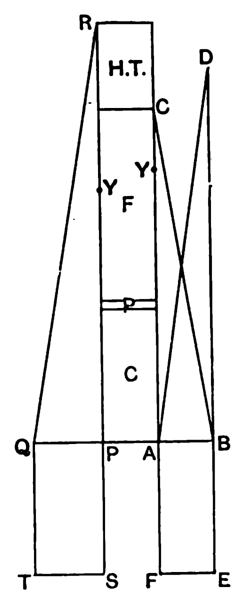


FIG. 12.

P the part due to phosphorus. In this instance the manganese was not present in sufficient quantity to add to the tensile strength. The area marked *F* represents the tensile strength due to ferrite alone in this class of steel, and the rectangle, which is the difference between the observed and calculated tensile strength, represents the portion of the tensile strength added by the heat treatment and annealing.

Not only the hub shell, but also the spoke ring and the withdrawal ring that go to complete the outer hub are analysed, tested, and microscopically examined in a precisely similar way. To check the correctness of the dimensions chosen for the hub shell, the finished shell was tested under torque, as already described, and under spoke tension — (1) by inserting spokes and pulling them in a Denison machine, and (2) by building up into a wheel and steadily increasing the tension (which was measured as described below) until permanent deformation occurred.

To ascertain the resistance of hub shells to impact, wheels built up with experimental shells are tested with the impact pendulum. To check the care with which the annealing is done, tensile tests and analyses are made on pieces cut from the finished shells to see that the carbon is not "burnt off," and that the elastic limit is not lowered.

Spokes.—Though the great care exercised in choosing and maintaining the quality of hub-shell steel is necessary, still greater is that necessary in the choice and maintenance of suitable material, structure, dimensions, and design for the spokes. This is required because of the variation of tension to which they are subjected. An alternating tension test is used to subject them to variations like those experienced by a spoke in a wheel. In addition to this, all consignments of spokes are tested for tensile strength, elongation, and contraction, near the head and on the swaged part, and a longitudinal median section is examined microscopically to see if the pearlite grains have the dimensions that have been found most suitable. The next slide shows micro-photographs of longitudinal median sections of a motor spoke which did good service in the Isle of Man Tourist Trophy Races, and of a bad motor spoke which broke in use. The microscope also detects undue internal strains set up during heading. Occasional analyses are made.

To check the accuracy of the initial tension on the spokes, wheels are taken at random from the stores and the tension on each spoke is measured. To do this two spokes, one outside and one inside, are fitted into a hub, nipples screwed on, and a pull applied to the nipples in the Denison testing machine. The pitch of the notes emitted at different tensions by the spokes when twanged is then compared with whistles and tuning-forks. In this way a scale of tensions is found for each spoke which corresponds to a definite scale of whistle notes. The spokes in the *wheels* are then twanged, and their pitch—and therefore tension — ascertained by these whistles. The spoking machine now used in building these wheels goes far to ensure uniformity of tension.

The microscope has proved useful in controlling the spoke threads. The threads on Rudge-Whitworth motor (and cycle) spokes are not cut in, but rolled out of the metal. In this way the diameter and strength obtained at the base of the thread is greater, for the rolling process jumps up the metal, strengthening it by the cold working it gets. With the microscope the actual displacement of the metal can be accurately followed by observing the positions taken up by the pearlite grains, and the degree of cold working at various parts of the thread can be gauged. Lines of weakness can be detected at once, as also imperfection in the outline.

Nipples.—The material from which the nipples are made has to be of high tensile strength. Consignments are tested for tensile strength, elongation, and contraction. They are also analysed and occasionally tested with the impact tester. Of course, nipples and all other parts of these wire wheels have their essential dimensions gauged by a large staff of expert viewers, but as this work—though scientific in so far as "science is measurement"—is really outside the work of the laboratory, it is omitted from the present account.

Rims.—The stresses to which rims are subject are complex. As already pointed out, load bends the rim, flattening it where the load is borne. This varying flexure will spread to the rim bead, making it bend and unbend to a slight degree. Another and more important cause of the bead bending is due to the tendency of the cover to pull away. This is proportional to the air pressure and the radius of the air tube section. For a tyre pumped up to 90 lbs. per square inch, and with an inner tube 4 inches in diameter, the force on 1 inch of the bead and perpendicular to it will be 180 lbs. This force will vary in magnitude, being greater near the ground and when rounding a corner, and will call into play transverse strains.

In testing rims, therefore, a section one inch wide is taken and tested by applying a pull to hooks made to imitate the bead of a motor tyre, and the elastic limit and yield point recorded. The tensile strength, elongation, and contraction are determined of pieces cut transversely as well as lengthwise, and the rims are occasionally analysed, tested for resistance to impact and microscopically examined.

Tyres.—Although tyres are somewhat outside the limits indicated by the title, the influence of the wheel on the tyre is too close to omit reference to them. One characteristic feature of wire wheels that contributes to reducing the tyre depreciation, viz., power of absorbing shock, has already been mentioned. There are others. The rise of temperature of tyres after a quick run is familiar to all. The hand cannot be held on the treads, cold water is converted into clouds of steam, and actual measurements on racing car tyres (*Automobilia*, August, 1908) show that at 135 kilometres per hour the temperature reached by the cover and air tube were respectively 132° C. and 96° C. This is in part due to friction between the ground and the tyre tread just as it is leaving and retouching the ground owing to the inequalities of the road surface, etc., in

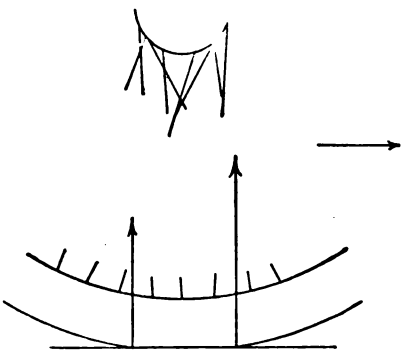


FIG. 13.

part to friction in the canvas or fabric, and in part (and probably in greater part) to the fact that when the stress in rubber is considerable, and its temperature is a few degrees above 8° C., both extension and compression cause rise of temperature (Todhunter and Pearson's "History of Elasticity," vol. ii., part 1, page 477). As the temperature of the tyre rises, the tensile strength of the rubber diminishes, and the energy stored in the rubber and not returned on leaving the ground increases rapidly. This not only leads to further rise in temperature, but to further softening, greater elastic hysteresis, and to increased resistance to the forward motion of the four wheels. This is easily seen from Fig. 13. From measurements made by the Palmer Tyre Company, the loss for one tyre may be as high as one-half horse-power. The bearing of this on the construction of wheels is that the steel rim, which conducts much of the heat away, is, in the case of a wire wheel, able to leave its heat behind, whereas the wood felloe (which has only one fourteen-hundredth the conductivity of steel) insulates the rim of the wood wheel just where cooling is most needed. Bearing in mind that the cost of rubber tyres is something like 23 per cent. of that of the raw material used in a 14 horse-power live-axle motor-car, the urgent need for something to mitigate the cost of their upkeep can readily be grasped.

The cost of tyres, including one spare, for such a car varies, of course, but taking it at £40 per set of five, their cost is about 13 per cent. of the finished car. Rudge-Whitworth wire wheels for such a car would cost (not including inner hubs) about £17 10*s*., 5·8 per cent., and, needless to say, the depreciation due to use is far less on this 5·8 per cent. than on the 13 per cent. due to the tyres. Unfortunately, I have no figures comparing the wear of tyres on Rudge-Whitworth wire wheels with the wear on other wheels, but the impression that wire wheels really do save the tyres is steadily gaining ground among motorists.

SOME OTHER MODERN WHEELS.

The defects and cost of tyres have led to a quickening of interest in spring wheels, and many attempts have been made to obtain sufficient resilience by employing springs in place of air enclosed in rubber.

In 1906 a spring-wheel contest was held in France. There were thirteen entries, two cars forfeited, and one was put *hors de combat* by an accident while landing at Boulogne. Of the ten that started, six depended for their resilience upon the application of rubber, and four used metal springs only. The only three that finished the 1,300 miles were of the rubber type; the metallic springs broke down early.

The chief defect in spring wheels, and one that is inherent in the system, is the considerable mass of steel that is required to give the necessary resilience. This is consequent on the numerical value of the elasticity of steel and the high factor of safety necessary under alternating stress.

The greatest amount of energy that can, without permanent set, be absorbed by a spiral spring of solid wire weighing 1 lb. is about 50 foot-lbs. This figure can be doubled by employing a hollow spiral tube with thin walls. A straight wire of spring steel weighing 1 lb. will safely absorb 60 foot-lbs. The shocks due to irregularities and obstacles on the road may reach many thousands of foot-pounds, and since the energy to be absorbed varies as the

square of the velocity, it is obvious that for high speeds enclosed air, which will take up a practically unlimited amount of energy, is much more suitable than springs.

In the Reid-Reikie spring wheel there are sixty-four spiral springs, each weighing 3 lbs., or nearly 200 lbs. for springs only in each wheel, and each spring has a free radial movement of only about one-quarter inch.

An improved spring wheel capable of transmitting drive to the outer rim was invented by the Hon. R. C. Parsons, and many other types are to be found in the publications of the Patent Offices.

have spokes made of flat steel-plates bolted to flanges on the rim. Usually the spokes are on two cones intersecting between the rim and the hub.

The Sankey wheel for motor-cars is made of sheet steel and looks much like an artillery wheel. By means of a number of stamping and drawing processes, a plain disc of steel is moulded into the shape of a half wheel. These halves, welded together by oxy-acetylene, form a light wheel which, as shown by the diagrams of tests exhibited, possesses considerable strength.

Fig. 14 shows a line-drawing of hydraulic

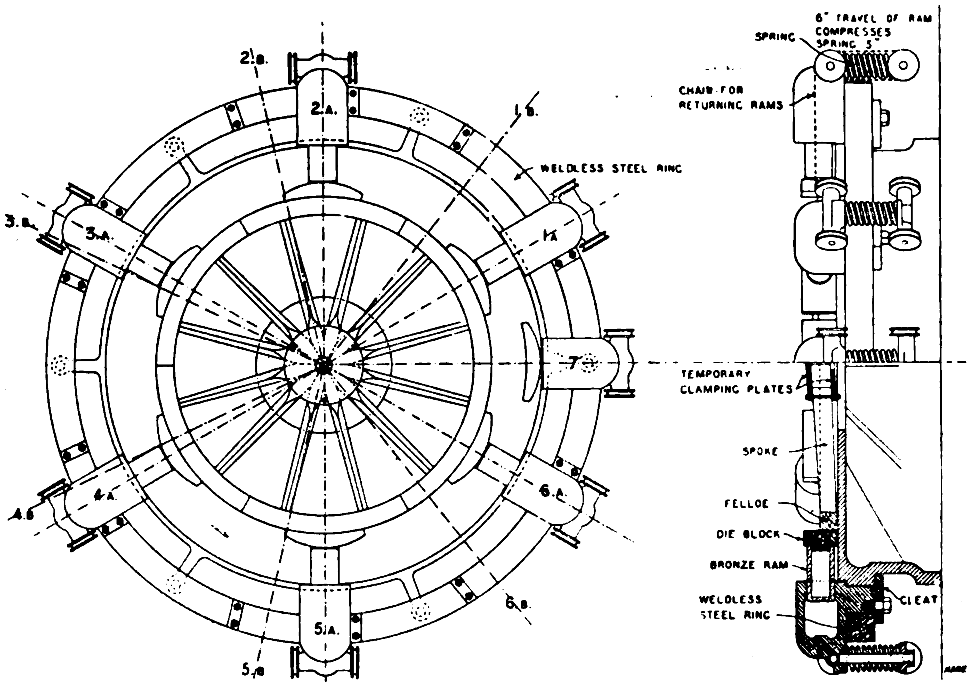


Fig. 14.

Railway waggon wheels are now usually made of steel. The flanged tyre is rolled from a punched billet and shrunk on to the wheel. This is usually of cast steel, and is forced on a forged steel axle.

The next slide shows two types of steel wheel made by the Shrewsbury and Challiner Tyre Company. These are built up by welding H and T section girder-steel spokes to steel flanges at the centre and steel rims by means of the oxy-acetylene blow-pipe. When T section steel is used for the spokes they are arranged on two cones intersecting at the rim. The wheels used on the London Omnibus Company's motor omnibuses are of cast steel.

Thorneycroft truck and traction engine wheels

rams used for building wood wheels. A wheel-setter, built much on these lines, is used at the Royal Woolwich Arsenal, where the practice is to heat the iron tyre, but not to red heat. The degree of compression produced by the contraction of the tyre depends on the yield-point of the metal, and this is very low in red-hot iron; consequently, after putting on the hot tyres, the rims are used to compress both tyre and wheel, the final tightening being performed by the contraction of the rim.

I will now conclude by showing on the screen a number of photographs illustrating the appliances used at the Rudge-Whitworth works for making and testing their wire wheels.

DISCUSSION.

The Chairman said it would be agreed that the paper was a very interesting one, and had covered a great deal of ground. The references to the ancient history of the wheel had been particularly interesting. It was just as well that Mr. Heathcote was not a consulting engineer to Pharaoh; if he had been, the Israelites would have had a bad time. He was sorry the paper did not deal with the manufacture of locomotive wheels, as it was a most beautiful industry: the way in which the spokes were welded together was quite a work of art. Many of those wheels were now cast in steel, so that what was to him a very beautiful manufacture was now passing away. The wire wheels were a beautiful piece of work, but he did not think the author had quite made out his case with regard to the strength of them against side shocks, as compared with wooden wheels. The wheel was designed in a dished form, i.e., the outer spokes were attached to the hubs, which were further away from the rim of the wheel than the inner spokes, and in that way there was a better angle of tension. But if such a wheel got into a tramway or other rut, the force was exerted outwards as well as inwards, and the wheel was not so strong to resist a shock of that sort as it would be if the wheel came up against the kerbstone. But in a wooden wheel the spokes were as strong one way as the other, so that he thought the wooden wheel had scarcely had a fair chance at Mr. Heathcote's hands. He (the speaker) did not think wooden wheels were dished to increase strength. One saw waggons with their wheels dished and the axles bent, which was an ingenious contrivance to ensure the wheel always pressing against the inner collar on the axle. In that way the backward and forward movement of the wheels on the axles, which was sometimes heard in a cart, was got rid of. The tensile tests on the spokes of the wheel mentioned by the author were evidently carried out while the wheel was in motion; consequently the apparatus for testing must be in motion too. He would be glad to hear how that was done when Mr. Heathcote replied. Wire wheels were very pretty, but if they went wrong in a country place where there were no Rudge-Whitworth shops, there would be delay and difficulty in getting them put right; whereas in most places there was a wheelwright who could repair a wooden wheel. He would be glad to hear what was the weight of the wire wheels compared with that of the ordinary wooden wheels, and also those manufactured by Messrs. Sankey, which were now being largely used, especially for cars going abroad, in consequence of wooden wheels not standing high temperatures.

Mr. H. M. Wyatt reminded members that when he recently read a paper before the Society, he touched on the subject of wheels. It was a very important matter in connection with the heavier kinds of motor transport, and especially in countries where the motor-car for transport was only developing. The wheels of cars running in this country were not usually of sufficient diameter to meet the requirements of the potential user in less developed districts. The wheel should not be dependent on complicated contrivances which required the constant presence of an expert. The question was still further complicated by the fact that the increase in the size of the wheel meant an increase in the size of the solid rubber tyre to go on the wheel; and if the user had to pay more for the tyre, he was less likely to take what the manufacturer offered him. He would be glad to know what was the cost of these wheels compared with that of other wheels which served a similar purpose; for instance, the cost of the wheels for a Daimler omnibus compared with the Sankey, or the Shrewsbury, or the Challiner. In regard to weight, he did not know that Mr. Heathcote could show figures which proved the superiority of the wire wheel over all others in this particular. It seemed that a very heavy expense in connection with wire wheels was the cleaning. To clean 500 pairs of wire wheels would be a much greater task than cleaning a similar number of sets of pressed or cast-steel wheels. He could see the advantage of the wire wheel for certain types of work, but was there any limit? If so, he would be glad to know where it lay. In the wheels exhibited, the length of the hub was greater compared with the diameter of the wheel, and if the same kind of wheel were designed for a tractor or other large vehicle, requiring five feet across, the length of the hub would be so great that it would affect the total overall width of the vehicle so much as to make it, possibly, unsuitable for use. The side-strains in those big wheels would have to be met, and he could see no way of doing that, except by lengthening the hub. The cross-strain, from skidding, etc., would also have to be met, and the ideal way of meeting that would be by spokes projecting horizontally, inwards and outwards from the rim of the wheel, parallel to the axle, and there would have to be discs to support the outer ends of the spokes of the size of the wheel itself. So one could eliminate spokes altogether, and get a disc wheel. It was partly for that reason he thought there must be some limit to the weight that could be borne by wire wheels.

Mr. E. G. Beaumont remarked that the reader of the paper said that the life of tyres on the wire wheels was longer than that of the wooden one; and the suggestion seemed to be that this was partly due to the fact that they were spring or resilient wheels. That was a view which he (the speaker) scarcely shared, and he would be glad to know whether it was due to the greater resiliency of the wheels, or to their increased lightness. The weights given (for four wheels) were, he believed, 149 lbs., and 179 lbs. respectively. That difference alone would go far to account for the greater durability of the tyres. Where other metal wheels had been used, and the

number of spokes was less, there had been considerable difficulty when fractures occurred at the junctions of the spokes with the rims; and it had only been by much strengthening of the junctions, or by adopting more spokes, or spokes of a form which had more than one junction with the rim, that the wheels had been made to stand. In the early days of the Michelin tyre that was a difficulty, and it was interesting, as the blows which led to the fracture were delivered through the pneumatic tyre, which one would look upon as the weaker part of the wheel. With regard to the author's statement that it was possible for a force of 5,000 lbs. to be delivered to the wheel from the road, that was to him a surprising figure, because the limit of effort would be set by the adhesion of the tyre on the road, and that was always considerably less than unity. The temperature rise in the wheels of recent cars was interesting. There was only a small figure of horse-power loss as the result given by the Palmer Tyre Company; one-half horse-power loss was mentioned. He (the speaker) had made similar calculations of temperature rise in different cases, and had found that loss 5 per cent. of the power in some cases. He asked whether the author had figures of that nature, or whether he had made similar calculations. The difficulty of cleaning the wheels had been mentioned, also the destruction of the wheel by corrosion. The latter he did not regard as of much consequence, as it could be dealt with, but the cleaning did seem to be a difficulty. With regard to the dished agricultural waggon wheel, there was an example where the axle was not only inclined downwards so as to ensure that the wheel should hug the inner side of the axle, but also was forwardly inclined for the same reason, so that even when there had been wear, it still had no tendency to drift away in the direction in which it would run off the axle.

Mr. JOHN PUGH said the lecture had been a very interesting one, especially in its historical treatment. And he was very glad the paper took a broader view than the particular trade which Mr. Heathcote was interested in. Wheels were the most fundamental example of what mankind had done. In Nature there was nothing of that kind for locomotion; the invention of wheels was entirely man's work. Ordinary modes of locomotion were jerky; even the motion of the horse was so jerky that riding it was recommended for cases of torpid liver. Where the animal had more legs, as the centipede, though the average general motion seemed more regular, it was yet made up of a series of jerkings forward. The time limits made it necessary for the lecturer to confine his remarks to wheels which touched the ground; but even in other spheres of human activity, civilisation had been marked by a departure from reciprocatory motion and going on to rotation instead. The turbine was a case in point, the advantages of which were well expressed when one remembered that the peripheral velocity of turbines varied from 15,000 to 60,000 feet per minute; whereas in racing motor-cars the highest recorded piston speed was about 4,000 feet per minute. With regard to the weak and the strong side of the dished wheel, the wheels his (the speaker's) firm were marketing were stronger from their weak side than the wooden wheels which were fitted to motor-cars, always taking properly comparable cases. He had never seen a wheel which had been broken in use by impact from the inside, perhaps for the reason that kerbstones did not run down the centre of roads, and that a violent skid could scarcely terminate with the contact of the kerb with the inside of the wheel. Even if it did, the tendency would be for the wheel to lift up and get over the obstacle. He did not condemn wooden wheels; they were beautiful things, and had been developed through the centuries, and he admitted they were much easier to clean than wire wheels. If Mr. Heathcote had not got figures dealing with the weights, he would be very glad to supply them for the information of the Society.

Mr. HEATHCOTE, in reply, said he had not measured the tension on the wheel when running. The diagram he exhibited showing the zig-zags was a hypothetical one. They were simply cosine curves. It was easy to repair a detachable wheel if the spokes broke, much easier than repairing a wooden one. The rider carried one or two spare spokes, which were easily fitted. Roadside repairs were, however, unnecessary if, as was usually the case, the car carried a spare wheel which could be fitted in a few seconds. Where weights had been compared, the advantage was found to be with the wire wheels, and they were also stronger. He did not claim that their wheel was the lightest on the market. With regard to cleaning, the wheels had been designed to stand cleaning with a hose, as the bearings excluded water. He did not see any reason why the load to be sustained should be limited: the case he quoted in which eighty-six people were on a motor omnibus was a very good test. He did not think that lorry or omnibus hubs projected outside the wheel. The rim on heavy vehicles had to be very wide. Some of the wheels for heavy loads were built with double egg-cup hub, with a cylindrical part in the middle, and two cones, one at each end. Some of the spokes went from each side of the hub to both sides of the rim. They had been shown to be adequate for loads far outside ordinary commercial requirements. Motor-car wire wheels were used on vehicles up to 90 horse-power. He was much interested in the Chairman's remarks about locomotive wheels, and in Mr. Beaumont's remarks. As to whether he would attribute the extra life of tyres to the extra resiliency or to the smaller weight, he thought the lengthened life was due to several causes, in which resiliency had a good share, and decrease in weight accounted for very much.

The temperature rise would be less in a wire wheel than in a wooden one. With regard to the case in which the stress was 5,000 lbs., the car in that instance weighed a ton, and Mr. Worby Beaumont mentioned a case in one of his writings which worked out at 7,500 lbs. for the side-thrust under similar conditions. But so great a side-thrust was not likely to arise unless the road was uneven and sloping. With regard to the loss of power due to tyres, he had no figures of his own.

A vote of thanks was accorded the lecturer on the proposition of the Chairman.

HOME INDUSTRIES.

Earnings of Agricultural Labourers.—The fifth of a series of reports relating to the earnings and hours of labour of workpeople in all trades in the United Kingdom is now available. The present report is the third which has been published by the Board of Trade on the wages, earnings, and conditions of employment of agricultural labourers in the United Kingdom, the first having related to the year 1898 and the second to 1902. The average earnings in 1907 of the predominant class of agricultural labourers, when compared with the average earnings in 1898, show a rise of 5 per cent. in England, and of 8 per cent. in Scotland, but as compared with the earnings at the date of the second inquiry (1902) the averages of 1907 show little change. There are considerable differences in the rate of wages, not only in the four countries but in different counties of each country. The average total earnings in the year in England is £47 15*s.*, in Wales £46 16*s.*, in Scotland £50 19*s.*, in Ireland only £29 4*s.* The county in England with the highest average earnings was Durham, with 22*s.* a week, and the lowest Oxfordshire, with 16*s.* 4d. The county in Wales with the highest average earnings was Glamorganshire, with 19*s.* 3*d.*, and the lowest Cardiganshire, with 16*s.* 6*d.* In Scotland, Dumbarton had the highest average (21*s.* 7*d.*), and Caithness the lowest (14*s.* 6*d.*). In Ireland the highest average earnings were 14*s.* a week in Antrim, and the lowest 9*s.* 8*d.* in Roscommon. These earnings are those of adult male farm-servants regularly employed, the earnings of lads, women, and girls having been excluded, and also those of men temporarily engaged at the busy seasons of the year. In comparing these earnings with those of labourers in industrial towns, it must be remembered that the rent of cottages is much lower in country villages than in towns. The village labourer has also better opportunities for growing vegetables, or of obtaining them at low prices, than the urban workman. The holidays allowed without loss of pay to agricultural labourers are few. In England and Wales the only days generally recognised as holidays are Christmas Day and Good Friday, though in most cases occasional extra days are granted. The allowance in Scotland is, in the majority of cases, from two to eight days, five or six being the most usual number. In Ireland there is more variation, no holiday being recognised on some farms, while on others as many as ten days are often observed.

The Hours of Shop Assistants.—There is general agreement that legislation is necessary for the better regulation of shop labour; the difficulty is how to bring it about. Seven years ago an Act was passed which it was hoped would improve the position of the shop assistant, but in fact it has been little better than a dead letter. The hours of shop assistants are much too long—there can be no difference of opinion as to that; and the obvious course would seem to be the compulsory closing of shops. But there are serious difficulties in the way of this drastic procedure, and the Government do not propose to take it. Instead, they limit the working hours of the week to sixty, exclusive of meal times, plus a certain amount of overtime under some system of factory legislation, and Sunday trading is to be rigidly limited to those trades where it is absolutely necessary. The Bill will require a good deal of amendment in Committee, but with the goodwill of the whole House it may be hoped that it will end in an Act which will be of some service to those on whose behalf it has been framed. Experience, however, warns against great confidence as to its working. It often happens that an Act of Parliament is either inoperative or works in a way contrary to the intention of its framers. It is not easy for Parliament to prevent excessive hours of labour in shops when, as will happen in many cases, employers and employed are agreed in desiring to evade the Act. Thus one provision of the present Bill provides that a father and one son may keep their shop open as long as they please, but a second son employed ranks as a shop assistant, and has his hours limited. That differentiation will hardly work in practice. Again, Jewish traders who have observed the Jewish Sabbath are to be permitted to keep open on Sundays to serve only Jewish customers. But how is the Christian who chooses to trade with them to be identified? Some of these puzzles will, no doubt, be solved before the Bill becomes law, and it is probably safe to say that a certain measure of good may be expected from the Act, but the working of the Eight Hours (Mines) Act warrants scepticism as to the realisation of present hopes.

The Cotton Trade with Greater Britain.—The statistical tables recently published relating to British self-governing Dominions, Crown Colonies, Possessions, and Protectorates, give some interesting figures relating to the trade in cotton goods between the United Kingdom and Greater Britain. Out of a total trade valued at £36,671,000, foreign countries supplied only £4,241,000. Last year the increase in the value of Lancashire exports was £12,471,000, and as regards quantity alone £2,981,000,

the average increase in the ten years up to 1909 being £2,400,000. Of cotton waste we send to the colonies nine times as much as foreign countries; of yarn, twist, and thread nearly eight times; of piece goods over twelve times; of miscellaneous goods two and a half times; and of unclassified goods nearly two and a half times. Britain sends to the colonies nearly thirty-nine times as much plain piece goods as foreign countries do, but only seven times as much dyed and printed piece goods. British predominance is greatest in the East Indies, the African possessions (outside South Africa), Australia, New Zealand, and Newfoundland. It is less in South Africa and the West Indies, where the total trade is small, and least of all in Canada, where the United States are such formidable competitors.

Painters' Materials.—The painting trade has to reckon just now with almost unexampled dearness in some of the principal materials it requires. For example, the present price of turpentine is about 74*s.* per cwt., as compared with 26*s.* 6*d.* per cwt. touched in 1909. In 1905 the price reached 63*s.* 6*d.*, but since then there has been nothing approaching the present price. The higher price is mainly due to a falling-off in the output. The principal supplies come from the United States, Russia, and France, but mostly from the United States, which send us at least 75 per cent. of the total imports. Russian turpentine, which is much cheaper than American, is beginning to find more favour with consumers owing to the more scientific methods now being applied to its production. Linseed oil again is quoted at about £47 per ton, which is the highest price touched within living memory. This, too, has been brought about by shortage in the supply. The linseed crops both in the United States and the Argentine—the two chief sources of supply—have partially failed, and the consumption has until recently tended to increase. The original estimates of the surplus of linseed from the Argentine this year were in the neighbourhood of 900,000 tons, but they have gradually shrunk until the generally accepted figure is now not more than 400,000 tons. The United States are the largest consumers of linseed oil, but their own crop of linseed this year is much below the average, and a considerable portion of the supplies of Plate seed which would otherwise come to Europe are being diverted to America. The Indian crop is reported to be very good, but it will not, by a long way, make up for the deficiency in the American crop. Substitutes are being used by consumers, but even here they are hampered by the smaller arrivals of soya beans.

The Milk Bill.—The importance from the national point of view of good milk, and plenty of it, and the admitted deficiencies in the present system by which it is conveyed from the cow to the consumer, make it very desirable that the Milk Bill now before Parliament, for which the Government are responsible, shall become law. Something has been done in recent years to improve the conditions under which milk reaches the public, but we are still far behind many Continental countries in this respect. If the Government Bill is passed, no farmer will be allowed to sell milk until the sanitary arrangements of the farm and the healthiness of the cattle have been certified. Where these are good, a permit will be given for milk to leave the farm. If the public can be persuaded that milk comes from sanitary and veterinary-inspected farms, much of the present distrust should disappear, with the result that the consumption of milk will be largely increased.

Flax Production.—Anxious to maintain the present high prices ruling for flax, Russian cultivators are being advised that their interests will be best served if the area put under cultivation for the new crop does not show an increase of more than 20 per cent. as compared with the old one, the theory being that high flax prices will be maintained if Russian growers do not increase the area under cultivation beyond the percentage named. The need for encouraging the cultivation of flax in all countries where conditions are favourable is being made evident, and the Union of European Flax-Spinners has, during the past year, obtained samples of flax from Japan, Canada, Mexico, and several of the South American States, the retting operations being carried out under proper supervision in Belgium, France, and Holland. The results are said to be very satisfactory, and to indicate clearly that much may be done if cultivators in those countries only receive expert assistance in the best methods of retting and general treatment of the fibre for export. At present three-fourths of the world's supply comes from Russia, but the quality of the fibre is inferior. The extent of flax cultivation in Ireland is still considerable, but the acreage has been gradually diminishing during late years.

Canal Schemes.—The Mid-Scotland Ship Canal National Association have decided in favour of a sea-level canal, 29 miles in length, between Yoker on the Clyde and Grangemouth on the Forth. Other proposals have been favoured in the past. One scheme would have deepened and widened the present Forth-and-Clyde barge canal, either with locks, as at present, or with huge hydraulic lifts at the ends of the present summit level, which is 150 feet above the sea. Another proposal was known as the Loch Lomond scheme. Loch Lomond is only 22 feet above mean sea-level, and was to be connected by a short canal, on the one side with Loch Long, and on the other with the Forth. From the Forth to Loch Long would be 54 miles, and another 15 miles would bring a ship to the Firth of Clyde. Only two locks would have been required, but there would have had to be two very deep cuts at the outlets from Loch Lomond. Alternative cuts from Loch Lomond to the Clyde were also suggested. A strong argument in favour of the Loch Lomond scheme was the possibility of

establishing a shipbuilding and repairing depot on Loch Lomond, well out of the range of an enemy's guns. The direct route now favoured has been proposed before, but as a locked canal with twelve locks and a maximum height above sea-level of about 90 feet.

English and American Yarns.—Why is it that English cotton-spinners can make a more even yarn than their American competitors? The Americans have as good machinery as the English; in some of the American mills the machinery is the same make—then why the inferiority? The question is put by the *Textile World Record*, which gives as the answer the quality of the labour employed. American spinners "do not, or cannot, get the 'help' to give the same attention to the details of the work that they do in England." Putting aside Lancashire's climatic advantage, which might perhaps be overcome by artificial means, the writer gives a list of details, neglect of which by American operators is said to be the cause of inferiority in yarn. But this only means vigilant management, and management is highly specialised in the United States. Perhaps the explanation is to be found, at any rate in part, in the fact that in America the keynote of the trade is production, whereas in English mills, though output is vital, there is less readiness to make some sacrifice of quality to ensure it.

CORRESPONDENCE.

ART EDUCATION IN THE JEWELRY, GOLDSMITHING, AND ALLIED TRADES.

In the discussion following Mr. George Heming's paper, Mr. Henry Wilson, in reply to Dr. Garnett's question as to how far machinery might be applied to artistic crafts, argued that not only could the spinning of metal be legitimately used in the silver trade, but that "spinning artists" might be encouraged!

The meeting was held to discuss art education in the jewelry, goldsmithing, and allied trades, and at the commencement of his remarks Mr. Heming said, "the demon of the machine pulled us down." Now the spinning-lathe is one of the claws of this disintegrating monster. It was, in conjunction with the decay of the apprenticeship system, one of the main reasons for the establishment of technical classes; it was one of the reasons why a critic called silversmithing "the most degraded of all British arts," and it is one of the causes for the lavish display of cheap and showy goods in the windows of pill vendors and fancy goods bazaars.

The spinner cannot be an artist. He is a mechanic rubbing metal into a chuck, which is generally provided for him. He can no more be considered analogous to the potter than the metal-stamper to the smith.

Besides the sentiment which attaches to wrought work, there is substance and durability. It is impossible that the antique silver, which is now so much prized, would have survived had the metal been spun upon the lathe. It was fashioned by consummate craftsmen, whose subtle fingers had indeed demonstrated that veritably "by hammer and hand all arts doe stand." Mr. Wilson said: "It was the man behind the machine who always had to be considered." Alas! there is much more in that than appears on the surface. It is the one man on whom all others are to be dependent; upon whom they are to rely for their daily bread, which they may earn by mechanically and monotonously producing replicas of his work. Shall we develop the divinity of man in this way; shall we make the daily work "more than a mere struggle for our daily bread"? Brought into daily touch with the trade as editor of a trade journal, and with the young as technical instructor, I see too much of the demoralising effects of strictly commercial production and the domination of the many by the man behind the—I was going to write Maxim gun—machine.

Every object made by means of the stake and raising hammer has behind it the most subtle of all machines imposing his individuality, and frequently consummate insight and ability, upon the object he is fashioning. On the other hand, the spinner is a conscious machine, merely pressing his material on to a pattern, and, like the stamper, automatically producing another's design upon another's model.

Mr. Wilson cannot realise how craftsmen—both masters and men—who have been injured and disheartened by this machine, have suffered, and how hopeless it seems to those of us who are anxious for the good of our craft, when we hear our champion as apologist for that curse of the modern smith—the spinning lathe.

W. AUGUSTUS STEWARD.

Central School of Arts
and Crafts, W.C.

My wife and I were both greatly saddened at the paper on the above subject, and much of the subsequent discussion, wondering why, after sixty years, this educational ploughing of the sands should so hopelessly go on. Mr. Heming must indeed be an optimist if he is not really blind to the fact that he and his fellow-enthusiasts are on entirely wrong lines, and are going in an exactly opposite direction to that which they desire. Surely the great art work of the world has not been effected by the wholesale manufacture of designers. The very traditions cited by Sir George Birdwood—who probably knows more about the arts of the ancient world than anyone present—referred rather to the patient continuance in well-doing of the craftsman, than any consideration of an emulative designer. Since 1851 we have gone on, more or less, trying to create designers in this

country. What has been the result? Have we not, in ninety-nine cases out of a hundred, spoilt a probably good craftsman by making him a discontented, because uninspired, artist? The lecturer and his friends would continue this process, with the logical and inevitable consequence, to the workshop, of it being occupied by a number of people, not so much interested in that patient continuance in their craft I have alluded to, as in the suppression of their own immature ideas. The speaker in the discussion who asked us to educate our shopmen, who showed the pretty things over the counter without the power to describe them adequately, set the true seal, not only upon this paper, but upon our whole system of educational training. For the intelligent prosecution of a craft the only art training necessary is the practical geometry and elementary free-hand drawing, of which every boy should know something. If he has the ambition and feels within him the divine afflatus of design, he can get the necessary training and art education—he will get it—and that without any forcing.

I will only touch on the machinery question—it need not have been dragged in. Any machine is obviously only a workman's tool—even the Syracusan coin owes something to a machine.

PHILIP H. NEWMAN.

39, Brunswick-square, W.C.

OBITUARY.

SIR CASPAR PURDON CLARKE, C.V.O., C.I.E., LL.D.—Sir Caspar Purdon Clarke died on the 29th of March, after a long illness. He became a member of the Society in 1884, and read papers before the Society on "The Domestic Architecture of India," "Street Architecture in India," "Modern Indian Art," and "English Brocades and Figured Silks," for two of which he received the Society's silver medal. He also took part on numerous occasions in the discussions, and often contributed to the *Journal*.

He was born in 1846, and was a student in the National Art Training School, where he won medals. He was originally educated as an architect, and in 1867 he was engaged in the architect's office of the South Kensington Museum. An early piece of work, which obtained him much credit, was his building for the Legation at Teheran in 1874. One of the first things which brought him into public notice was his arrangement of King Edward VII.'s Indian presents in the galleries afterwards devoted to the Indian Museum at South Kensington, and for his services on this occasion he was awarded the C.I.E. in 1882. After this he was employed on various commissions for acquiring art objects for the South Kensington Museum in Greece, Turkey, Syria, and India. The most important of these expeditions was perhaps the one he carried out for the Indian and Colonial Exhibition of 1886. In 1883 he was appointed Keeper of the Indian Collections. Nine years later he was advanced to the post of Keeper of the Art Collections of the South Kensington Museum. In 1893 he became Assistant Director of the Museum, and, after the death of Sir Philip Cunliffe-Owen, was appointed Director in 1896. This post he held until 1905, when he resigned, and was appointed Director of the Metropolitan Museum of Art in New York. After holding this post for some five years, he resigned it and returned to England.

In addition to his official work in connection with the Science and Art Department, he did a great deal in connection with various exhibitions, especially those of which the British Section was under the superintendence of Sir Philip Cunliffe-Owen. He also built the Indian Palace for the Paris Exhibition in 1889, and it was under his superintendence that the elaborate Indian buildings, which formed an important part of the Indian and Colonial Exhibition, were constructed. He was knighted in 1902, and obtained the C.V.O. in 1905.

NOTES ON BOOKS.

SIX GREEK SCULPTORS. By Ernest A. Gardner, M.A. MEDIAEVAL ART. By W. R. Lethaby. WILLIAM BLAKE. By Basil de Selincourt. London: Duckworth & Co. 5s. net a volume.

The series of volumes constituting Messrs. Duckworth & Co.'s "Library of Art" has proved so successful that it has been decided to reissue them in a cheaper form. The new edition will doubtless be warmly welcomed by many students of art who found the price of the first issue more than they could afford. The series has already taken its place as a standard library of art criticism. The contributors have in each case been carefully selected, and the list includes only those who can speak with authority on the subjects with which they deal.

No one is better fitted, both by training and instinct, to deal with Greek sculpture than Professor Ernest Gardner. A classical scholar of the first rank, he was for eight years Director of the British School at Athens; he was also engaged in excavation in Egypt, Cyprus, and many sites in Greece, and has written much on various branches of Greek art and archaeology. In the present volume, the six sculptors, Myron, Phidias, Polyclitus, Praxiteles, Scopas, and Lysippus, are selected; their work is described and criticised in a singularly appreciative and sympathetic style, and the influence of the earlier artists upon their successors is carefully explained.

In dealing with mediaeval art, Professor Lethaby has a very wide field to cover. Starting with the age of Constantine, he proceeds to describe later Byzantine origins, Romanesque art in Italy, Germany,

France, and England, Gothic characteristics, French cathedrals, sculpture, and painting, and so on through Gothic art in England, Spain, Switzerland, Belgium, and Germany, to his concluding chapter on Gothic art in Italy. With a subject extending over ten centuries and the greater part of Europe, it goes without saying that a volume of this size does not afford scope for anything like exhaustive treatment. With this limitation, however, Professor Lethaby's account is admirable, and well calculated to stimulate the student to further study, which is perhaps as great a compliment as one can pay to a book of this description. A word, too, should be said in praise of the well-chosen illustrations, some of which are very striking, notably the West front of Strasbourg Cathedral, the West door of Sens Cathedral, the door of the North transept of Reims Cathedral, and the choir of Rouen Cathedral. The student who has assimilated these, and Professor Lethaby's account of them, will begin to have a good idea of what is meant by mediaeval art.

It is difficult to write with sanity and moderation about the visionary, William Blake. His admirers see in his work so much more than meets the ear or eye; his detractors regard him as little better than a lunatic. Mr. Selincourt appears to have hit the happy mean. While appreciating Blake's lofty ideals and fine enthusiasm, he is by no means blind to his faults as man and painter, and he has consequently written a discriminating book, giving perhaps the best account of Blake that has yet appeared. Whatever one may think of Blake's poetry, or his art, or his theories about art, one can hardly deny that he was a most remarkable character, and one that, for its human interest alone, will repay a little study.

Notes on Practical Cotton Finishing. By J. Harold Edge, F.C.S. London: The Trades Papers Publishing Co., Ltd. 3*s*. 6*d*.

The nature and scope of this little volume are accurately described by its title. Mr. Edge passes from a very short account of the history of cotton finishing to a brief note on the various kinds of cotton fibre; he then proceeds to deal with water in the finishing works, softeners, and conditioners, starches and fillings, antiseptics, blues, etc., and concludes with a useful and fully illustrated chapter on finishing machinery. The subject is dealt with from an eminently practical point of view, and is written in language that should be intelligible to the master and foreman finisher. The tests given for trying the purity of the water, and the materials used in finishing, have been prepared so as to enable those engaged in finishing work, who have not been trained in chemistry, to apply technical and scientific tests with reagents they can understand, and to obtain results they can follow. Mr. Edge writes with considerable authority, for he has had opportunities of studying finishing work in America as well as in Europe.

GENERAL NOTES.

The Corrosion of Metals.—The Corrosion Research Committee of the Institute of Metals is now actively engaged in preparing for an elaborate series of investigations into the causes of the corrosion of brass condenser tubes. A special condenser is being constructed, which will contain forty-eight tubes, twenty-four of these being made of commercially pure brass, and the remaining twenty-four tubes of brass containing a single selection from lead, tin, aluminium, manganese, or other material at the discretion of the committee. Experiments will be made with various water speeds in the ratio of 0 : 1 : 2 : 3 : 4, speed 2 being an average speed used in practice. The circulating water to be used will be obtained from deep water at Formby, off Liverpool, in the first instance, and the plant for the corrosion research will be installed in the University of Liverpool, where the experiments will be under the direct supervision of Mr. G. D. Bengough, M.A. It is expected by the committee that the research will prove to be one that will occupy many months before any definite conclusions can be reached, and it will undoubtedly be costly. Though the total amount received (£242 5*s*. 6*d*) is sufficient to enable the work to be commenced, the cost of the research must ultimately be very much greater than this. If the research is to be properly carried on, the expenses will probably amount to not less than £300 per annum. Donations should be sent to Mr. G. Shaw Scott, M.Sc., the Secretary of the Institute of Metals, at Caxton House, Westminster, S.W.

Patents in 1910.—The report of the Comptroller-General of Patents, Designs, and Trade Marks, for the year 1910, has been issued as a Parliamentary paper. During the year there were 30,388 applications for patents; of these 20,768 were provisional, 19,105 were complete, and 16,269 were sealed. The corresponding figures for 1909 were 30,603, 21,553, 18,705, and 15,065. The applications received from women inventors numbered 671, as compared with 648 in 1909. There were 1,482 applications made by way of communication from abroad, of which 728 came from the United States, 431 from Germany, 53 from Italy, 33 from India, 25 from Switzerland, and 21 from Austria. The number of applications made in this country under the provisions of the International Convention for the Protection of Industrial Property by the various States of the Union in 1910 was 2,829, an increase of 526 as compared with 1909. The number of designs applied for during the year was 30,872, excluding 1,873 sets of designs, as compared with 24,816 single designs, and 1,596 sets in 1909. The number of designs registration of which was refused was 591. Applications were made for the registration of 10,623 trade marks as compared with 10,880 in 1909. The number registered was 5,722, as against 6,112 in 1909.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

APRIL 26.—NOEL HEATON, B.Sc., F.C.S., "The Production and Identification of Artificial Gems."

MAY 3.—A. W. GATTIE, "London Transport."

MAY 10.—HAL WILLIAMS, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

MAY 17.—Professor RAOUL PICTET, "Les Basses Températures."

MAY 24.—FRANK M. ANDREWS, "Architecture in America." Sir ASTON WEBB, C.B., R.A., F.R.I.B.A., will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

APRIL 27.—Sir THOMAS HENRY HOLLAND, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India." Lord AVEBURY, D.C.L., LL.D., F.R.S., will preside.

MAY 25.—W. R. H. MERK, I.C.S., C.S.I., LL.D., "The N.W.F. Province of India."

COLONIAL SECTION.

Tuesday afternoon, at 4.30 o'clock :—

MAY 9.—F. WILLIAMS TAYLOR, "Canada and Canadian Banking."

CANTOR LECTURES.

Monday Evenings, at 8 o'clock :—

ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal : its Structure and Uses." Four Lectures.

Syllabus.

LECTURE I.—MAY 1.—*The External Form of Rock Crystal and Chemical Character of its Substance.* Early Observations of its Geometrical Shape, and Conclusions drawn therefrom as to the Nature of Crystals in General—The Modern Conception of a Crystal—Measurement of the Angles between the Faces of a Quartz Crystal, and the Facts thereby Deduced—The Plan or Scheme of Arrangement of the Faces, and the Occurrence of Right and Left-handed Varieties of Quartz.

LECTURE II.—MAY 8.—*The Internal Structure of Rock Crystal, and the Means we possess of Elucidating it.* The Chemical Molecules of Silica, and their Arrangement in a Space-lattice — The Influence of the Arrangement of the Elementary Atoms in the Molecule of Silica in Determining a Right or Left-handed Screw Structure—The probable Disposition of the Atoms and Molecules in the Right and Left Varieties of Quartz, and the Effect of this Internal Structure in determining the Outward Geometric Form—Revelation of the Oppositely Helical Structure by Etching and Liquid Cavities.

LECTURE III.—MAY 15.—*Optical Evidence of the Two Complementarily Opposite (Mirror-image) Screw Structures.* Rotation of the Plane of Vibration of Polarized Light in Contrary Directions by the Two Varieties of Quartz—Experiments on the Artificial Reproduction of the Quartz Phenomena, in proof of the suggested Screw Structure—The Twinning of Quartz and Apparent Enhancement of the Symmetry and Destruction or Modification of the Optical Activity thereby—The Interesting Case of Amethyst—The Magnificent Polarization Phenomena of Twinned Quartz.

LECTURE IV.—MAY 22.—*Scientific and Industrial Uses of Rock Crystal.* Its Thermal and Electric Properties, and its Transparency to Ultra-violet Rays—The Construction of Prisms and Lenses (including spectacles) of Rock Crystal, and their Advantages over Glass—The Use of Quartz for Balance Weights and in connection with the Interferometer—The Artistic Use of Quartz for the Carving of Vases and other Objects—Destruction of the Crystalline Structure by Fusion, and the Uses of Fused Silica in Fibres and Scientific Apparatus.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 10...Institute of Brewing (London Section), Criterion Restaurant, Piccadilly, W., 8 p.m. Mr. B. T. P. Barker, "The Principles and Practice of Cider Making."

Optical, at the Chemical Society's Rooms, Burlington House, Piccadilly, W., 8 p.m. Mr. H. S. Ryland, "The Forms and Errors of Visual Lenses."

Geographical, Burlington-gardens, W., 8.30 p.m. Mr. Douglas Mawson, "On the Plans of the Australian Antarctic Expedition, 1911-1912."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. R. Anning Bell, "Coloured Relief as Decoration."

East India Association, Caxton Hall, Westminster, S.W., 4 p.m. Mr. K. Vyasa Rao, "A Statutory Royal Viceroy for India."

TUESDAY, APRIL 11...Asiatic, 22, Albemarle-street, W., 4 p.m. Sir J. George Scott, "The Religions of the Shan States."

Engineers, Junior Institute of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 7.30 p.m. Major B. Baden-Powell, "Recent Progress in Aeronautics."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. J. W. Smith's paper, "The Improvement of Highways to Meet Modern Conditions of Traffic," and on Mr. H. P. Maybury's paper, "Recent Development in Road-Traffic, Road-Construction and Maintenance."

Photographic, 35, Russell-square, W.C., 8 p.m. Messrs. C. E. Kenneth Mees and C. Welborne Piper, "On the Fogging Powers of Developers. Part I. General Introduction. The Hydroquinone Developer."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. Mr. C. W. Boyd, "The Development of Rhodesia."

WEDNESDAY, APRIL 12...Automobile Engineers, at the Institution of Mechanical Engineers, Storey's-gate S.W., 8 p.m. Mr. A. Mallock, "The Effects of Wheels on Roads."

Japan Society, 20, Hanover-square, W., 8.30 p.m. Mr. E. F. Strange, "The Art of Kyōsai."

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FRIDAY, APRIL 14, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

CONVERSAZIONE.

The Society's Conversazione will be held this year at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday, May 30th, from 9 p.m. to 12.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A Meeting of the Colonial Section was held on Tuesday, April 4th, 1911, the Right Hon. Lord DENMAN, K.C.V.O., Governor - General Designate of Australia, in the chair.

The CHAIRMAN said he considered it a great honour to have been asked by his noble friend, Lord Blyth, to take the chair that afternoon on such an interesting occasion. He gathered that the paper was one of a series delivered under the auspices of the Society concerning each of the over-sea dominions. He thought, particularly this year, when so many fellow-subjects from across the seas were visiting this country to attend the Coronation ceremonies, it was obviously desirable that every opportunity should be taken of gaining an increased knowledge of those dominions. He himself hoped to do so that afternoon, for he stood perhaps more in need of such knowledge than any other man in the room. There was just one point which he should like to mention. No one at all conversant with Australian affairs could fail to notice how many sailors had given their services to that country. He would mention, as examples, the late Sir Harry Rawson, the popular Governor of New South Wales; Admiral Sir Frederick Bedford, for some years Governor of Western Australia; Admiral Sir Day Hort Bosanquet, who at the present time was the Governor of South Australia; and lastly, Captain Collins, who for many years was in the Royal Naval Service. Captain Collins had been intimately associated for many years with the naval defence of Australia. He had been Secretary of the Department of the Defence of the Australian Commonwealth for four years; he had been the representative of the Commonwealth Government in this country, and during that time not the least of the services he performed was the establishment of the office of the High Commissioner of the Commonwealth in London. It would be very easy for him (Lord Denman) to say a good deal more concerning the services which Captain Collins had rendered to Australia, but he thought he had said enough to show how well qualified he was to address the members of the Society, and he was sure he would be able to rely upon an attentive and appreciative audience.

The paper read was—

THE COMMONWEALTH OF AUSTRALIA.

By CAPTAIN R. MUIRHEAD COLLINS, R.N., C.M.G.,

Official Secretary in Great Britain for the Commonwealth of Australia.

To endeavour to speak comprehensively and clearly of any young country within the short space of a paper is a formidable undertaking, but it is much more formidable when that country is a continent in itself. If you would in a moment comprehend something of the wide range of Australia's climate, soil, production, and scenery, you cannot do better than run your mind over all the various climates, soils, products, and scenery which you know exist in Europe. For Australia is just as various in all these things as is Europe, with tropical regions added. In her great stretch from north to south she embraces lands to which the inhabitant of any country on the Continent of Europe might be transplanted with any of his industries without suffering hardship or even change. In Australia we could find districts into which each and every European engaged in primary production could be made to feel at home.

As has been pointed out by Mr. Knibbs, the Commonwealth statistician, Australia, by reason of its insular geographical position and the absence of striking physical features, is far less subject to extremes of weather than are regions

of similar area in other parts of the globe, and, latitude for latitude, Australia is far more temperate.

The range of summer and winter temperatures in Australia, as in other countries, increases with increasing distance from the coast, but even in the interior, where the heat is greatest, the nights are cool, and the extreme dryness of the air renders the heat easily bearable and very healthy.

Such is the magnificent climate; but there lurks in the minds of many people the association of droughts with Australia, and the idea that we have a country with a fringe suitable to settlement and a huge interior desert. It is necessary to correct this impression. Droughts we have had, and droughts we shall have. It has taken the colonists some time to learn the lesson of drought, and to realise that it can be fought. With increasing knowledge, with improved methods of farming, with irrigation, the evil effects of drought steadily diminish. So it is with land classed as desert. It may be said, as science advances, the desert recedes.

The possibilities, however, of Australia, as regards rainfall and production, can at once be realised by a consideration of the following facts:—For some time land with an annual rainfall in excess of 18 inches, provided the soil is of good quality, has been considered suitable for closer or farming settlements. Well, it is computed that Australia has no less than 529,000,000 acres of this. Now, when you consider that the total area of France, with 40,000,000 people, is not quite 133,000,000 acres, and the total area of Germany, with 60,000,000 people, is not quite 136,000,000 acres, and the total area of Spain, with 20,000,000 people, is not quite 126,000,000 acres, you can have some idea of the vast area of land available for production in Australia, and conceive how it must be destined as a home for a great people. But we can evidently go further than this margin of rainfall. Recently a conference, convened by the Minister of Agriculture in South Australia, was held at Adelaide to consider the question of dry-farming. Expert officials from all parts of the Commonwealth attended. It was pointed out that many millions of acres of agricultural land, of which the rainfall varied from 10 to 16 inches per annum, were awaiting development. The Minister of Agriculture said that South Australia alone had 30,000,000 acres, and that last season 55 per cent. of the wheat produced in that State came from land having less than 16 inches rainfall. It can be seen from this what a revolution is being effected by dry-farming.

Australia is a land unrivalled in the production of wool. It is interesting to recall the fact that a Governor, in the early days of settlement, reported that the country was not suitable for sheep. Australian pastoralists have made increasing efforts towards the development of their flocks. When pure merino rams were first introduced into Australia from Spain, they averaged about 3½ lbs. of wool. To-day the stud merino ram yields over 40 lbs., and the average for the million of flock sheep is nearly 8 lbs. at each shearing.

Our mineral resources are only partially developed or explored, yet the total value of mineral production for 1909 was over £23,000,000, and the total yield of gold since 1851 is over £525,000,000. The deposits of coal and iron are enormous.

As a wheat producer, we are but in our infancy. The production of wheat for last year was 89,735,000 bushels, of which 28,943,000 centals, valued at £9,922,000, was exported. It is stated that the area at present under wheat represents probably one-twentieth of the lands of Australia fitted to produce crops under existing conditions of cultivation, and probably only one-fortieth of the area on which wheat could be grown under scientific methods of dry-farming.

So much for the climate and resources. Our possibilities have so much impressed one of the Scottish Agricultural Commissioners, who have recently returned from a visit to Australia, that he said it appeared to him that Australians did not sufficiently appreciate them. We are not supposed generally to be a modest people, but here is testimony to the contrary.

What is being done to make Australia attractive and profitable to the settler, whether he be native-born or a new arrival from the Mother Country, can only be sketched in outline in a general paper of this kind. The first phase in our land settlement was pastoral settlement. Then came the farming settlement on areas which, although small from the early grazing point of view, were extraordinarily large when compared with the average size of farms in other countries.

We are at this moment embarking upon the third stage, which means the intensive cultivation of areas much smaller than those held by our farmers up to the present time.

I shall mention as an illustration what is on offer by the Western Australian Government. The land-seeker there can acquire an area of good farming land up to 1,000 acres in extent for a

deposit of 3*d.* an acre. He will pay from 15*s.* to 25*s.* for excellent wheat-growing country, and be allowed twenty years in which to pay for it. In addition to that the Government Agricultural Bank will advance him up to £400 without any security but the land upon which he has paid 3*d.* an acre. This £400 is to be spent upon horses and implements, and fencing and clearing, and other improvements, and is paid to the settler as he makes his purchases or carries out his work. This means that an approved man, with practically no capital at all, can become the possessor of a farm which will give him a very substantial income indeed. The Hon. James Mitchell, Minister for Lands in Western Australia, declared the other day that 80 per cent. of the settlers in recent years had less than £50 of their own at the time of entry.

When you consider that Western Australia is now carrying farmers and farm-labourers from the Mother Country to the State at £2 a head, which means that the Government is paying £10 towards each immigrant's fare, and that there is a great demand there for farm-labourers, and that wages are high, you will see how easy it is for a young man in one of the rural districts in Great Britain to become a farmer in Western Australia.

Australia is sometimes charged with being indifferent on the question of immigration, but I think that this example of what this one State is doing to make its empty spaces available for the young Britisher should convince the world that we are deeply in earnest in the peopling of our country. And what is true of Western Australia is more or less true of the majority of the States. Most of the States provide cheap steamship fares, and all of them offer plenty of work at good wages. Then a wide choice of lands available, as I have shown, on remarkably easy terms, makes the way very easy for the man who enters Australia with the capacity and determination to succeed as a settler on the land.

We have still a long way to go in Australia before we shall have disposed of all the well-watered country suitable for dense farming settlement. The good rainfall area is in itself capable of carrying a very big population. But that is only the beginning of our opportunities for settlement. We have, in addition, splendid areas of land available for irrigation. It is often said that Australia's rivers are relatively insignificant, but still it has been unmistakably shown that if their waters are properly conserved and distributed over the soil, instead of being allowed to run to the sea, they will become a most important factor in our national wealth.

The purpose of irrigation will be the increase of the output on the lands already settled, and the indefinite expansion inland of the areas suitable for farming. A remarkable feature of the inland country is its sweetness. Hundreds of miles from the coast, where the rainfall is scanty and the good seasons intermittent, the soil is in the good years thickly coated with a great crop of natural grasses and herbage which are nutritious right down to the ground. This ample territory of light rainfall is always ready with its prolific response to moisture. Give it water, and it will grow almost anything.

Round some of the artesian bores of the interior one finds beautiful oases of native grasses and edible shrubs, of lucerne, cereals, and many varieties of fruits. There is the combination of sunshine and rich land reaching out almost interminably over a surface undulating very slightly, if not quite level. Add to this water, and you turn thousands of square miles into a garden.

The recognition of these facts has already led to some irrigation enterprises of considerable magnitude. And in irrigation, as in so many other fields, you find the State playing an important part. American irrigation is largely the result of private enterprise, which has gained perpetual rights over the most important irrigation waters. In Australia the State has decided to give no freehold rights over its running streams. In the big works now in hand the Government constructs the head and other conservation works, and also the main channels of distribution, and sells the water to the landholders at cost price, plus working expenses. This means that water for irrigation purposes in Australia is, in the opinion of experts, the cheapest in the world. Generally speaking, too, the State purchases large areas of the land about to be watered, and disposes of this under easy conditions to the settlers.

In the State of Victoria, which, although by no means the least favoured by rainfall, has pioneered irrigation in Australia, we find that already £3,500,000 have been spent on the construction of irrigation works during the last twenty-five years, commanding for irrigation over 1,000,000 acres, and giving a stock and domestic water-supply of over 6,000,000 acres.

In order to obtain settlers for these areas, the Government in 1910 despatched a delegation to Great Britain and America, the purpose of which was to secure desirable settlers for the Victorian

irrigated areas. The delegation's efforts resulted in remarkable success; already from Great Britain alone 1,300 people with their families have applied for irrigation blocks in Victoria, representing a total capital of £230,000. The State Government estimates that during the next twelve months all the available land commanded by the present water storage will be taken up, and is, therefore, undertaking further storage works, and in the near future additional large tracts of irrigable country will be offered to settlers.

It is not astonishing that this irrigated country in Victoria has been rushed by settlers from both the Mother Country and America. The scheme is aimed at people who possess a little capital, and the State assists to a remarkable extent. For instance, take the case of a man who goes out from England. He is loaned four-fifths of his steamship fare. When he lands in Melbourne, he is offered good board and lodgings at a special State lodging-house for the sum of 2*s*. 6*d*. per day. He gets special concessions over the State railway lines, and is given the fullest opportunity of seeing all that is on offer. We will assume that he buys a block of sixty acres. His farm will not be in its primitive forest state, but will be country which has been under ordinary unirrigated cultivation for many years. The State will build him a house and give him several years in which to repay the money, and also assist on the same basis in the buying of live-stock and implements and the effecting of improvements.

There is no rough pioneering, no isolation about this new phase in our settlement. The irrigable land is all situated close to old-established railways and prosperous country towns marked by pleasant social life. The channel of pure river water which flows through or past each settler's block means that very soon he will have a beautiful as well as a prosperous home.

It is anticipated that the present rush of settlers will speedily exhaust the irrigated land available in Victoria, and so it is good to be able to say that an even bigger scheme is approaching maturity on the other side of the Murray, in New South Wales. In this State a great dam, with a capacity for conserving water eleven-twelfths as much as that conserved by the famous Assuan Dam across the Nile, is being constructed across the Murrumbidgee River at Barrenjack.

Then South Australia is also initiating works on a big scale. And one is safe in saying that for many years ahead we shall be duplicating these schemes and making large areas of land available for the stranger from oversea.

As an illustration of what is proceeding in Australia under the policy of repurchase of land and closer settlement, the Surveyor-General of South Australia reports as regards his State:—"In order to prove that the subdivision of large estates has been most successful it is only necessary to record that prior to repurchase by the Crown the population, so far as can be ascertained, on 465,208 acres of freehold land was only 387, and there were also 269,700 sheep, 1,828 cattle, and 709 horses. To-day, on the same land, there is a population of 4,313 (including 2,002 children), and in addition the stock comprises 111,099 sheep, 7,073 cattle, and 6,217 horses; 73,860 acres were under cultivation last year for cereals and hay, and there were 1,721 acres of gardens and orchards, while 928,242 bushels of wheat and oats and 16,150 tons of hay were taken off last harvest."

The position to-day is that we in Australia have the surplus lands, and that you in the Mother Country have the people who can settle those lands, and thereby add to the wealth and the strength of Australia, and at the same time add to the wealth and the strength of the Empire as a whole. Every additional acre we settle, every additional ton of produce we win from the soil, means more strength, and, if need be, more fighting strength, to the British people.

Before I pass on to another subject, I would like to refer to the subterraneous waters which form a remarkable and interesting feature in connection with the development of Australia. There is an artesian area of over 640,000 square miles. Large supplies of water have been tapped, but it is found that artesian waters in some cases are charged with alkali which is inimical to fertility. The attention of Mr. Symmonds, a chemist in Sydney, was drawn to this, and he applied himself to the investigation of a means of neutralising the injurious effect of the alkali on growth. He found that soil from these districts, when treated with rain-water, was highly fertile, but treated with artesian water it became acid and caked. He then tried the effect of nitric acid applied to the bore-water, and this gave surprising results. The soil became richer even than when treated with rain-water. Here was an interesting discovery; but then came the question how to give it a wide application and commercial value. Mr. Symmonds proposed to adopt the method which is in certain cases now applied to the manufacture of cordite, and get his nitrate from the atmosphere. But this

might be an expensive process, so he proposed to use the power of the bore-water itself to carry out the work of extracting the nitrate.

His investigations, however, have carried him further, to find that in the shallow bores the water was strongly charged with carbonate of soda, which is death to plant life, but that at greater depths the soda elements decreased, and the water was rich with fertilisers.

Concerning such investigations, Mr. Hunt, the Government Meteorologist, has written to me:—"I have been endeavouring to collect data relative to the results of tests made to discover a means of neutralising the effects of bore-water on adjacent lands. Senator Millen has taken a good deal of interest in the question, and, in response to inquiries as to his experience in the use of artesian water, I have received from him a letter, of which the following is a copy:—

"'Regarding the tests to which you refer, though no doubt interesting from a scientific point of view, they failed to suggest anything of commercial value. But even had they resulted otherwise, I doubt if the present use of the water would have been disturbed. Its value to-day for grazing is greater than its problematical value for irrigation. An artesian well will water 50,000 acres for stock purposes, whereas it would probably not irrigate more than 150 to 200 acres. The Department tacitly accepts this view, for it makes no pretence of putting down wells for any other than stock purposes. Bear in mind that there is a limit to the number of wells that can be put down with safety.

"'With regard to the "caking" tendency where irrigation is practised with artesian water, the same thing is observed in certain localities even where river water is used. I do not think the caking—by itself—would be fatal. It is the corrosive action of the soda, with which practically all our artesian waters are charged, that represents the real evil.

"'My own experience is still too brief to warrant the expression of definite opinions. Further, the water varies in every bore.'"

This is a subject that is very interesting, and of which no doubt we may expect to hear further, as closer settlement advances on those artesian areas now almost entirely pastoral.

I will now turn for a few minutes to the Australian Constitution and politics. The Federation, as you are doubtless aware, consists of six States, and differs from that of Canada, or that of the more recent South African Union, in that the powers of the Federal Government are more restricted. We still have six State Parliaments, each consisting of two Houses, of which the Legislative Councils of New South Wales and Queensland are nominated. With the exception of the Upper Houses in New South Wales, Victoria, and Queensland, members are paid. As Lord Rosebery remarked: "A land which will support so many legislators must be a land of exceeding great prosperity."

The legislative power of the Commonwealth is vested in the Federal Parliament, consisting of the Sovereign, the Senate, and the House of Representatives. There are six senators for each State, chosen by the people of the State voting as one electorate, and they are elected for a term of six years.

Half the senators for each State vacate their seats at the expiration of three years in the case of the election of a new Senate. One-third of the whole number of senators must be present to constitute a *quorum*.

The House of Representatives consists at present of seventy-five members. The Constitution provides that they shall be as nearly as possible twice the number of senators. It is elected for three years. The number of representatives to be elected is arrived at in the following manner: A quota is obtained by dividing the total population of the Commonwealth by twice the number of senators—*i.e.*, by the number seventy-two. Then the number of representatives for each State is got by dividing the population of the State by the quota. If there is any remainder from the division greater than half the quota, one more member is allotted to the State.

At the time of the establishment of the Constitution, provision was made for the payment to members of both Houses of a salary of £400 per annum. This has since been increased to £600 per annum. Both Houses are elected on adult suffrage, every man and every woman of twenty-one years of age being entitled to vote, and every vote is of equal value.

It is interesting to note the proportion of women voting to that of men. At the General Election, 1910, the percentage of electors voting to electors enrolled was, in the case of men, 67·58 per cent., and in the case of women, 56·17 per cent., and for the House of Representatives, 68·12 per cent. for men, and 56·93 per cent. for women.

Under Federal law voting by post is allowed, under the following conditions:—

An elector can vote by post: (*a*) Who on polling day will not be during the hours of polling within five miles of any polling place for his division; (*b*) Or, being a woman, will, on account of ill-health, be unable to attend; (*c*) Or if the elector will be prevented by serious illness.

Application has to be made for a postal vote certificate and postal ballot paper. The paper must be witnessed by a J.P., electoral registrar, medical man, or other person designated as qualified to witness.

The Commonwealth Government has taken over those affairs which may be roughly termed national. It controls external affairs, defence, Customs, post, telegraph, and telephone services, quarantine and shipping, and landing of persons in Australia. These are some of its functions, but it has powers not yet exercised; for instance, it is authorised under the Constitution to take over the control of the railways.

The chief functions of the State Governments may be said now to be the settlement of lands, the encouragement of mining and agriculture, and the control of education and State public works.

Since the establishment of the Constitution, the Federal Government has enlarged its powers by the means provided—namely, referendum. A referendum was taken in April, 1910, by which the Commonwealth obtained power to take over the whole of the State debts. Before this amendment the Commonwealth had only the power to take over the debts as existing at the time of Federation. At the time of this referendum 31 per cent. of enrolled electors voted in favour and 25 per cent. against. There were 29,249 votes by post.

We have lately had in England our attention drawn to the referendum. The referendum in Australia is embodied in the Constitution, but not as a means of settling any disputes between the two Houses, although there is provided a double dissolution of the Senate and the House of Representatives in the case of disagreement. Since Federation there have been three referenda taken. The first one, in February, 1907, dealt with the term of service of senators. This was carried. On April 13th, 1910, two questions were submitted to the vote. One was the taking over of the State debts, to which I have already referred, and which was carried, and the second was a financial agreement between the Commonwealth and the States, enacting a payment of 25*s.* per head of the population to the States from the Commonwealth revenue, in lieu of the clause of the Constitution known as the Braddon Clause, which provided that during a period of ten years after the establishment of the Commonwealth, the Commonwealth was annually to apply only one quarter of the net revenue obtained from duties of Customs and Excise to its expenditure. The balance—namely, three-fourths of the net revenue—had to be paid to the several States, or applied towards payment of interest on the debts of the several States taken over by the Commonwealth.

This proposed alteration was lost, the majority voting against it. But, since that, the present Commonwealth Government has passed an Act settling the financial relations between the Commonwealth and the several States, in view of the period provided for under the Braddon Clause having expired.

This Act provides that during a period of ten years, beginning on the first day of July, 1910, and thereafter until Parliament otherwise provides, the Commonwealth will pay to each State by monthly instalments, or apply to the payment of interest on debts of the State taken over by the Commonwealth, an annual sum amounting to 25*s.* per head of the number of people of the State. Provision is made for the special payment to the State of Western Australia of an annual sum, which in the first year shall be £250,000, and in each subsequent year shall be progressively diminished by the sum of £10,000. The Commonwealth Treasurer also, if he has a surplus revenue at the close of each financial year in his hands, after providing for the Commonwealth requirements, has to pay the amount over to the several States in proportion to the number of their people.

Two very important Acts for enlarged powers to the Commonwealth have recently been passed, which will be submitted to the referendum this month. One provides, as regards monopoly, that when each House of the Parliament, in the same Session, has by resolution declared that the industry or business of producing or supplying any specified goods, or of supplying any specified services, is the subject of a monopoly, the Parliament shall have power to make laws for carrying on the industry or business by or under the control of the Commonwealth, and acquiring for that purpose any property used in connection with the industry or business.

The other Act contains four amendments of the Constitution, which will have to be voted upon as one issue, and provides for increasing the powers of the Commonwealth under existing sections of the Constitution, to give complete control over trade and commerce, to deal with corporations, including their regulation and control, and with industrial matters, including employment and the wages and conditions of employment, and the prevention and settlement of disputes; and, further, to add a new section giving the power to the Commonwealth to deal

with combinations of manufacturers in relation to the production, manufacture, or supply of goods or services.

One of the most important Acts recently passed by the Commonwealth Parliament is the Northern Territory Acceptance Bill, by which this territory is taken over by the Commonwealth as from January 1st last. I may remind you that this territory thus sliced out from one State and taken over by the Commonwealth is in area larger than the whole Union of South Africa.

South Australia has previously administered the area, and, in taking it over, the Federal Government assumes responsibility for the debt of about £3,000,000, spent on its development, together with an obligation to carry through certain railway works. On every ground the action taken is to be commended, as it is a national concern of Australia to develop this territory adequately.

It is well adapted for the breeding of high-class stock. It is rich in minerals. Gold, tin, copper, silver, lead, and wolframite, are the principal metals which have been found, and a geologist, the late Mr. J. E. Tenison Woods, F.G.S., once declared—"I do not believe that the same quantity of minerals will be found in any equal area in Australia."

It is the aim of the Australian Government not to lose time in proceeding with the development of the territory. At the present time an exploring party, headed by a qualified officer, is making a journey of investigation into the country.

The Commonwealth also exercises jurisdiction over the territory of Papua, British New Guinea, which is now being actively developed. A notable expedition for exploration was recently organised under the leadership of Mr. Hanniforth Smith, and we have heard with great relief and satisfaction of the safe arrival of the party at Thursday Island after very great hardships.

Railways form a most important part of the development and consolidation of a new country. It is to be noted that over 60 per cent. of Australia's loan expenditure has been spent on railways and tramways.

There are at present 16,652 miles of railways, which are State-owned and managed, with the exception of 943 miles of private lines available for general traffic, and 637 miles privately-owned, used for special purposes only. The longest railway journey that could be taken now in Australia is from Longreach in Queensland to Oodnadatta in South Australia, a distance of 3,303 miles. From Adelaide to Brisbane is 1,790 miles. Large schemes of new railways are now under consideration in the majority of the States. It is a matter for regret that the railways were laid down in the different States without the adoption of a uniform gauge, and it is recorded in the life of Mr. Gladstone that when he was Colonial Secretary he strongly urged, in a despatch to the Governor of New South Wales, the importance of adopting a uniform gauge, as regards the future of this great continent.

Unfortunately, his advice was not followed, and as the development of the country proceeds, the necessity of improved communication arises, and the disabilities of the difference of gauge and the importance of unification are more and more pressed upon the public attention.

It is now recognised that the solution of this problem would facilitate the development of commerce, and the settlement of land throughout the Commonwealth. Fresh importance has been given to this subject, owing to the recent report of Lord Kitchener on Australian defence, and the difficulties that would occur under the existing conditions in the mobilisation and transport of troops from one State to another to assist in defence.

It was pointed out by a Minister in the House that to transport 30,000 mounted troops with equipment on active service from Melbourne to Brisbane, under the present break of gauge conditions, would take sixty-three days, whereas with a uniform gauge the time occupied would be twenty-three days ten hours. At the instigation of the Minister for Defence a conference has recently been held of the chief Railway Commissioners on this matter. The Prime Minister is reported to have stated that he was strongly in favour of early action, for he regarded it as matter of urgency, quite apart from defence considerations, as the present position leads to serious economic loss. He expressed himself as favourable to some equitable principle of contribution, but pointed out, when he talked of a uniform railway gauge, that he had in mind the uniform gauge between the State capitals. The total cost of a uniform gauge scheme has been set down at £5,000,000. There are two great projects for trans-continental railways. The first is to connect the railways of the eastern and southern districts of Australia with the Western Australian line by the construction of a line between Port Augusta in South Australia and Kalgoorlie on the Western Australian goldfields, a distance of 1,100 miles. The route is being surveyed, and it is expected that as soon

as Parliament sanctions the construction, the work will be begun without delay. Then there is the second trans-continental route, which will extend the main northern line from Adelaide, at the present terminus, Oodnadatta, as far as Pine Creek, the southern terminus of the northern territory line from Palmerston. The distance between Oodnadatta and Pine Creek, on the road followed by the telegraph wire, is 1,140 miles. These lines, when constructed, will, as it were, join up the continent.

A country worth living in is a country worth defending. The Federal Government have given proof more than once that they are in earnest in the question of defence. Our national spirit of independence, a spirit which you will agree with me, is in accordance with the spirit of the British of all ages, dictates that we should shoulder our own responsibilities. But whilst the measures are directed to making adequate provision to secure Australia from attack and to protect our commerce on the coast, it is recognised that as part of the Empire the training, organisation, and equipment should proceed on such lines of uniformity with the British Army and Navy as to secure efficient co-operation when the necessity of acting together in time of war arises. Very notable and marked advance as regards both military and naval defence of the Commonwealth has been made within the last twelve months. In the scheme of the Imperial General Staff, for which Lord Haldane is entitled to a great deal of credit, we have now the means of bringing the military forces of the Empire into some form of unity, a means of co-ordination of training and maintaining a standard of efficiency.

Following this the services of Field-Marshal Lord Kitchener were obtained to report and advise on military organisation for Australia. His report and recommendations have been practically adopted, and are now being carried out in a scheme of universal training. From the first of this year every male inhabitant of Australia who has resided there six months and is a British subject will be liable to be trained—(*a*) From twelve to fourteen years of age in the Junior Cadets; (*b*) from fourteen to eighteen years of age in the Senior Cadets; (*c*) from eighteen to twenty-five years of age in the Citizen Forces. And, in the case of imminent danger of war, from twenty-five to twenty-six years of age. The obligatory training does not apply to persons reaching the age of eighteen years in or before this year. It is estimated that, apart from the Junior Cadets there will be an immediate enrolment of 100 000 Senior Cadets. When the scheme is in full operation in 1919 to 1920, it is estimated there will be 114,000 men from eighteen to twenty-five years of age undergoing a course of training, with 13,000 men between twenty-five and twenty-six in the first line of reserve, making a total fighting force of 127,000 men between the ages of eighteen and twenty-six.

The Commonwealth has been divided into military areas, and area officers will supervise and direct the registration, organisation, and training of Senior Cadets, inspection of Junior Cadets in schools, administration of troops within the area, and training of all recruits.

In order to provide for the higher training of officers a military college has been established, and the services of qualified officers on its staff have been obtained from the War Office. The education at this college will be entirely free, so as to admit of any Australians qualifying for commissions. The estimated cost of carrying out Lord Kitchener's scheme is about £2,000,000 per annum.

Now, if we turn to Naval Defence we see an equally great advance, and the adoption of a definite scheme.

At the Naval Conference held in London it was recommended that an Australian Naval Unit should be formed, consisting of one armoured cruiser, three second-class cruisers, six torpedo-boat destroyers, and three submarines. The cost of this was estimated at £3,695,000, which sum, however, owing to improvements in type will be exceeded. The annual maintenance was placed at £750,000, towards which the Admiralty or Imperial Government offered to assist with a contribution of £250,000, until such time as the Commonwealth could take over the whole cost. The Commonwealth Government, however, whilst adopting the scheme, has decided to bear from the start the whole cost, and thus relieve the Home Government of any contribution.

The armoured vessel, two second-class cruisers, and two submarines are in course of construction in England. Three destroyers are completed, and a third second-class cruiser is to be constructed in Australia.

Following on this initial scheme, the Commonwealth obtained from the Admiralty the services of Admiral Sir Reginald Henderson to advise on the whole question of naval organisation and defence, and, as you will have doubtless noted in the Press, his recommendations involve a considerable development and the creation of a fleet, including the unit now forming, within twenty-two years, consisting of eight armoured

and ten protected cruisers, eighteen destroyers, and twelve submarines, at a cost of £23,000,000. When we regard these organisations for military and naval services, and their application to the general defensive strength of the Empire, I would like to call attention to the difference there exists in working out any Imperial problem of defence for the army and for the navy. It is quite possible to train the military forces of the various parts of the Empire separately in time of peace, and yet enable them to act efficiently together in time of war, but I have serious doubts about the efficiency of navies that are unaccustomed to act together in time of peace. A navy must work in peace as it is intended to work in war. Therefore, in connection with these local navies you will see how essential it is that, beyond the adoption of a common standard of discipline and training, they should in time of peace be accustomed to act with the home navy.

There is another point. Soldiers are trained within their territorial limits. A navy is not restricted to its territorial waters. It "shows the flag," and a ship may at any moment by some action raise an international question. It is plain that this problem of the navy leads you straight to the more complex and difficult problem of Imperial foreign policy.

In industry, in commerce, and in organisation for defence, we find Australia advancing with rapid strides. I have had no time to refer to education, which would require a paper in itself.

Australia has shown, too, her eagerness to take her share in those pursuits of science in which she is best fitted to participate, and for no scientific enterprise are her conditions more favourable than they are for solar research, for which her wealth of sunshine and clear skies especially endow her. This research, fraught with great scientific importance in that it seeks to establish the evolutionary theory of the celestial universe, and pregnant with possibilities of affording an instrument of great value to meteorologists, has been encouraged by the majority of the nations, and it now remains to supply a single observing station to enable the sun to be continuously observed throughout the whole of the twenty-four hours.

A movement with which Dr. Duffield, a young South Australian of distinguished scientific attainments, is associated, has started within the Commonwealth to effect the establishment of such an observatory within the boundaries of Australia, and Mr. Deakin, when Prime Minister, was prepared, subject to the approval of Parliament, to grant Government assistance provided that the necessary funds for its equipment (£10,000) be privately subscribed. Towards this amount £4,000 has already been received.

The Commonwealth thus hopes to complete the chain of solar observatories that girdle the earth, so that Australia may take her place among the nations in the international system of co-operation in this branch of science.

I must also refer, whilst on the subject of Australian interest in science, to the share she has taken in Antarctic exploration. Not only has she contributed in money to the Shackleton and Scott expeditions, but Sir Ernest Shackleton, whom I am pleased to see here to-day, can witness to the assistance given to him by Australians, such as Professor David of Sydney and Dr. Mawson of Adelaide. Dr. Mawson is here now for the purpose of organising a scientific expedition to proceed again to the Antarctic.

I think I have said enough to show that Australia is entering on a new era. One might correctly say that the nineteenth century in Australia was the century of pioneering, and that this is to be the first century of the harvest. The first sixty or seventy years were years of the navigator and the explorer, who blazed the tracks and showed the way, and revealed in the South-West Pacific a great, new, homing land for British people. Then followed the grazier with his flocks, and we had, until the middle of the century, an almost solely pastoral country, a land of vast individual holdings, of lonely homesteads, sheep and shepherds, horses and cattle, and little else. We had a vast wealth of fertile land, but a very narrow market for produce. Development was slow, the future indefinite. Then came the gold discoveries of the "'fifties," and in a year the whole outlook was changed. We drew population from all parts of the world, and apart altogether from the great value of the gold which was won, we had at once within our doors a strong and growing market for all the produce of the land. Farming on a large scale was at once made possible, and farming men who, up to that time, might well have been pessimistic about the new country's future, saw before them all the essentials for the making of a powerful nation. The country's politics assumed a new meaning; leaders confidently prophesied a great Australian people. For the next fifty years men in all parts of Australia worked with zeal and ambition, and nearly all the way prosperity waited upon their industry. As the population grew, and settlement went out from various points and met and overlapped,

and railways were built from colony to colony, and inter-State shipping was established, there came the irresistible impulse for a Federal Union. The physical conquest of the continent, vast undertaking as it was for a handful of people, still left a few big minds time to preach national ideas and union.

The beginning of the twentieth century found what might be called the colonial days almost at an end. Australia federated into a Commonwealth, and became a young nation. That was only eleven years ago, and the world has no parallel, I think, for the wonderful changes, both in thought and action, which these few years have witnessed. The broad fact is that Australian thought has undergone a series of extraordinary changes since the days when the six colonies became the six States of a central and national Government. And I think you will agree, that not only are we changed in our thought, but also that much of this new thought is already expressed in vigorous actions, taking such important forms as a great land settlement policy and a generous immigration campaign, both of which, working together, are indispensable to our growth and our national safety.

Then you will see that we are working strongly in the fostering of young industries, in the hope that we shall become self-supporting; while we are aiming to make Australia one of the happiest lands in the world for the worker of every class; to raise the standard of our civilisation; to provide for a greater diffusion of social well-being, free of those injustices and inequalities that so blot and disfigure the civilisations of older lands. Those are what might be termed home affairs—the making of a numerous and prosperous and contented people. In matters external I have shown you we are paying special attention to defence. In short, we are embarking on a new era in local and Imperial politics, in primary and secondary industries, in defence, and in our relations to the outside world.

DISCUSSION.

The CHAIRMAN, in opening the discussion, said the Society was much indebted to Captain Collins for his address, so clear and interesting in itself, and giving some idea of how a nation had been built up, and some conception of the vast possibilities of the Australian Continent. He himself did not propose to dwell on any of the topics discussed in the paper with so great ability, but as the present occasion was the first public function he had attended since his recent appointment, he might be permitted to make one or two observations which, in other circumstances, might be regarded as entirely irrelevant. In the first place he should like to say with how much interest and pleasure Lady Denman and himself looked forward to going out to their new position in Australia, and for his part he felt deeply the responsibilities of the task he had undertaken. Compared with former Governors-General of Australia, he suffered under the serious disadvantage of being new to the work which he would have to perform. Glancing over the list of his predecessors in that high office, he saw that two of them, the late Lord Linlithgow and Lord Tennyson, were Governors of Australian States before they took office under the Commonwealth. Lord Northcote, to whom he was already indebted for many useful hints, had previously been Governor of Bombay, and the present Governor-General, Lord Dudley, had filled the great position of Viceroy of Ireland. When he reviewed the services which those gentlemen had already rendered to the Empire before they assumed the office of Governor-General, he felt acutely the disadvantages of which he had spoken, but he believed, in spite of them, or possibly even because of them, he should be able to rely upon the proverbial Australian feelings of kindliness and comradeship—qualities which flourished perhaps more abundantly beneath the warmth of a southern sun than under greyer skies at home. Whilst he realised the disadvantages, he had also one or two advantages on his side. He went out, at any rate, to take up his new appointment without any prejudice or preconceived notions. He had had the advantage—a real advantage—of having been for over four years in the personal service of the late King, who was in touch with all classes of the community in this country, and with representative men of the overseas dominions. Also, since King George had ascended the Throne, he had had the advantage of being in the personal service of His Majesty, who knew the oversea Britains as few men had had the opportunity of knowing them, and as no previous English king had ever known them. He (Lord Denman) was well aware that no man took a keener interest than His Majesty in the development and the welfare of those Dominions. He also hoped before long to have the advantage of meeting representative men, such as Mr. Fisher and other Ministers of the Commonwealth, as well as Premiers and representatives of the States Governments, from whom he looked forward to obtaining valuable information and friendly counsel. When he took up his appointment in Australia he felt sure that he would be able to rely on the cordial co-operation of the States Governors. He had already had the good fortune of acquiring, if he were permitted to say so, the friendship of the first High Commissioner from Australia to this country, Sir George Reid, who had been kind enough to give him some excellent advice, and had placed the information obtainable at his office at his disposal. There was, however, one point on which he was

afraid he would be unable to take Sir George's advice, although he realised that that advice was perfectly sound. The High Commissioner and himself were discussing the question of public speaking, on which no man was better qualified to give an opinion than Sir George Reid, and he said: "When you go out to Australia I would advise you to give up that cold, frigid, calculating style that obtains in the House of Lords at home and import more warmth and life and enthusiasm into your addresses." He (Lord Denman) was sorry to say he could not; he had been a regular attendant at the House of Lords debates for a good many years, and it would be curious if he had not acquired something of its style of speaking—at all events, its faults without its merits; and anybody who expected anything different from him would be deeply disappointed. He had alluded to the fact that he had been, and still was, in the personal service of King George, and the post that he held at the present time was that of Captain of the Corps of Gentlemen-at-Arms, a Corps which made it its proud boast that since the time of Henry VIII. it had occupied the position of the nearest guard to the English throne. He had read in some old records of a letter written, at the time when James I. succeeded to the throne, by a former Captain of the Corps, Lord Hunsdon, to King James. The writer pointed out how useful the Corps had been to Elizabeth and her predecessors. The following were the exact words used by the writer in commending the Corps to James I.'s notice: "Inasmuch as it hath served them always as a nursery to breed up Deputies of Ireland, Ambassadors into foreign parts, Councillors of State, Governors of fortified places, Commanders in the war both by land and by sea." Australia could not be called exactly a fortified place in the sense in which it was conceived by the writer of those words some three hundred years ago, but Australia was strong in her youth and her vigour, strong in the belief in her own future as a nation, confident of her own powers of development, and, above all, strong in loyal attachment to the King and to the Empire. He made no sort of claim to speak on Australia's behalf as Captain Collins had spoken that afternoon—that, indeed, was a claim to which he could never aspire; but if a few years of faithful service in the country entitled a man to give his opinions on Australian questions in the Imperial Parliament, that was a right which some day he hoped to earn.

Sir JOHN M. F. FULLER, Bart. (Governor Designate of Victoria), said he was not capable of following the polished phrases and tactful references of the Governor-General Designate; all he would say to him, if he might be allowed to, was that if he would continue to make speeches so tactful and so eloquent when he arrived in the Continent over which he was to preside, his period of office would be successful and popular. Although, like Lord Denman, he went to Australia without any prejudices, he could not claim, like him, to be a stranger to Australia. Captain Muirhead Collins to whose paper all had listened with unfeigned pleasure, had referred to the creation of the Australian Commonwealth. It happened to be his (Sir John's) privilege in the year 1891, as the guest of Lord Jersey at Sydney, to attend day by day the sittings of that historic Conference presided over by Sir Henry Parkes, which laid, and laid firmly, the foundations of the Australian Commonwealth. Ten years after, as a member of the British House of Commons, it was his privilege to take part in the unanimous vote given in favour of the Act under which the Commonwealth was created. It would be a matter of surpassing interest to him to go back twenty years afterwards to Melbourne, a city in which he received nothing but kindness and hospitality, and see the immense progress which he was sure had been made in the State of Victoria and in her capital city. Captain Collins had said, and well said, that a country worth living in was a country worth defending. Although he was fully aware that the State Governors in Australia were in no way directly responsible for the defence of the Continent, yet he thought they might be able to do a great deal to encourage and foster the spirit of Imperial patriotism, and to assist Lord Denman and his Government in building up, upon the new compulsory system, a scheme under which Australia as a continent might rest assured that she was safe against the world. Captain Collins had said that the Continent of Australia was opening a new chapter in her history. When there was a new Governor-General and a new Governor of Victoria, it was obvious that a new chapter in her history was opening. He could only say for himself, and he knew he could say it for the Governor-General Designate, that they would do their very best to make that chapter a happy and prosperous one.

Sir FRANCIS J. S. HOPWOOD, G.C.M.G., K.C.B., said he was glad of the opportunity of adding his tribute to Captain Collins's excellent work. Captain Collins had done a great deal for the country for which he felt such deep attachment, especially in disseminating amongst people a greater knowledge of its beauties, its prospects, and its importance. After all, it was knowledge that was required, both in this country and in Australia. What he (Sir Francis) thought was of more importance than anything else was reciprocity in knowledge. It would be an immense advantage for the public men of this country to have a better knowledge of the dominions oversea. Imperial conferences contributed to that end, but after all they were the debates and discussions of the gods; they did not come the way of the ordinary man. Although many people had the patriotism and the sentiment, they lacked knowledge. That knowledge was to be obtained in the course of time by the cheapening of transport facilities, by giving greater scope for easy travel, and by cheapening the cost of postage and cable communication. Cable communication was most important, because it was by cable communication that newspapers derived the knowledge

and information of which he spoke. He hoped and trusted that his friend, Sir George Reid, would, during his period of office, use his eloquent tongue for the purpose of advocating an improvement in those matters.

Sir ERNEST SHACKLETON, C.V.O., said Captain Collins had referred to the generosity which Australia had extended to him (Sir Ernest). If Captain Collins had not referred to that fact he would not have spoken, but he would say that the first official help he received on his expedition was given by Australia; three of his best men came from that country—Professor David, Douglas Mawson, and Armytage. If any word of his that afternoon could go to help Douglas Mawson's coming expedition—an expedition to gain purely scientific knowledge—in the Antarctic, he hoped it would do so. Pole-hunting expeditions were very valuable things, and he hoped the British flag would eventually fly on the Pole, but Douglas Mawson's expèdition was going out without any glamour and excitement to do great scientific work on one of the stormiest and most difficult coasts of the whole world. That expedition would be a great benefit to Australia, on account of its researches in meteorology, which told people about their crops—of which he (Sir Ernest) did not know much. Australia had helped his (Sir Ernest's) expedition, and it was therefore fitting that the people of this country and the rich Australians in it should help Mawson in his expedition.

Lieutenant-General Sir EDWARD HUTTON, K.C.M.G., C.B., was pleased at being given the opportunity of asking the meeting to convey their thanks and appreciation to Captain Collins for an able and comprehensive paper. Before referring to the paper, he would like to congratulate Lord Denman upon going out to Australia and being associated there with the most warm-hearted, kindly, and hospitable people which existed on the face of the globe. There was no part of the Empire where valuable public services, heartily rendered, were more appreciated. With reference to the paper, he would like to say a word with regard to his being selected to propose a vote of thanks to the author. It was his privilege to be in Australia during 1893-96, and to have played some part in the establishment of the Commonwealth—that was to say, when the preliminary arrangements, based upon the Federal Defence of Australia, were carried through with that object in view—and also during the three eventful years, 1901-04, which followed the establishment of the Commonwealth. During that last period he was associated with Captain Collins in Defence matters, but he (Sir Edward) would not for a moment hesitate in saying that on all points he did not agree with Captain Collins. He thought those responsible for the present system of military defence which was evolved for Australia during that period might congratulate themselves, inasmuch as that system had been copied almost line for line by Lord Haldane in the establishment of the Territorial system in this country. The evolution of the Territorial system in Australia, not unexpected on his part, had been, as Captain Collins had said, universal military service. It was possible that there might be a like development in this country. Captain Collins had remarked upon the importance of the work recently effected by Field-Marshal Lord Kitchener. In that connection he would like to supplement what the author had said in his paper, and assure the meeting, and through them the people of Great Britain and also Australia, that sufficient recognition had not been given to those devoted soldiers and statesmen who, for fifty long years before Lord Kitchener went to Australia, devoted their time, their services, and in some cases their lives, to the solution of Australian military defence. There was some reason to fear that, by the omission of any reference in Lord Kitchener's report, the valuable services of many distinguished and devoted officers, who had contributed important and lasting work for Australia's defence, extending over a long period of years, would be minimised or forgotten. He would remind the meeting that in 1859 Australia was one of the first portions of the British Empire to establish the Volunteer system, and he would further remind them that in 1885, under the guidance of that great and far-seeing statesman, the Right Hon. Thomas Dalley, New South Wales was the first self-governing Colony to establish a co-operative system of defence for the Empire, by determining to send to Suakin, at the end of the campaign in the Soudan, a contingent of infantry and artillery. The numbers were small, but it showed to the whole world the determination of Australia to take part in the defence of the whole Empire, and to establish what Mr. Chamberlain had since emphasised as the principle upon which the Empire should exist, namely, "each for all, and all for each." Australia, therefore, had reason to be proud of her military past. He might also say a word with regard to the present. It would be within the recollection of all what valuable troops were contributed by Australia to the South African War. Those services were rendered voluntarily, and Australia was actuated by the determination to promote the unity and the solidarity of the Empire. He had great pleasure in moving a vote of thanks to Captain Collins for his paper, and in doing so he congratulated him most heartily, not only upon the paper, but upon the excellent services which he had been rendering the Commonwealth of which he was so able and valuable a servant.

Mr. W. M. KELLY (Member of the Australian House of Representatives) said, as an Australian, he felt singular pleasure in seconding the vote of thanks. Every person who understood Australia would be thoroughly satisfied with the very capable way in which the subject had been handled. He felt a peculiar satisfaction in being present, because he had had an opportunity of hearing so early a statement from the Governor-General

Designate of Australia, whose speech had, to a certain extent, lightened the regret which he, in common with all Australian politicians, felt in the resignation of the present Governor-General, Lord Dudley. He (Mr. Kelly) did not appear before the audience that afternoon as a missionary of Australian virtues, because he recognised that what virtues Australians possessed they shared with their race throughout the world, and what good fortune they held they owed to the Mother Country and the white ensign of England, which had protected Australia in all the years past. He would like to say that co-operation—a word that had been mentioned that afternoon—would not solve the problem of how the great self-governing dominions could take their part in the great fabric of Imperial defence. What was meant by the phrase, "The defence of Australia"? It meant, surely, the defence of Australian interests throughout the world. A few years ago Australia's idea was to prevent any hostile forces landing upon her borders. Then she came to see that some coastal force was necessary to protect her coastal shipping, and at the present time she is beginning to realise that the trade upon which the Australians lived, and the trade routes which enabled her to get her products home to the markets of England, might be threatened just as seriously in the British Channel as in the Pacific Ocean. Again, one could not point out any section of the world and say it was the duty of any particular portion of the Empire to defend that particular section; it had to be realised that that section was part of a great whole, which must hang together if it meant to exist. He thought the problem would be solved only by co-operating in the sense of trades-union co-operation, under one single management. They were a young nation in Australia, seeking to handle national responsibilities without having all the functions of nationhood. This country possessed a Foreign Office and diplomatic missions throughout the world, to see what other people were doing and thinking; and in the light of the information acquired in that way, and in the light of the education of the Home Parliament, this country framed a continuous assurance upon the national wealth and national security. Australia, on the other hand, had absolutely no participation in "foreign affairs," and that made it extremely difficult for her to take her part continuously and systematically in the defence of the great structure of which she was so proud to form a part. He felt strongly that if Australia's defences were to be continuous, if the defences of any British dominion were to be continuous, they must be framed in the light of the developments and complications of foreign policy. He felt that if Australia or any of the other dominions were to solve the question, the solution of it would come from some close reciprocal arrangement with the Mother Country, or by some still closer scheme for foreign defence purposes only, and not through the loose system of co-operation, of which so much was spoken at the present time.

The Right Hon. Sir George H. Reid, K.C.M.G., in supporting the resolution, said he had been quite delighted with the temperature which had been prevailing during the last few minutes—it reminded him of the more active years of his own political life when he could say what he thought. Australia had been very fortunate in the character of its representatives of the Throne, and he was very glad to know, from what he had heard of Lord Denman and of Sir John Fuller, that that happy train of experience which Australia had had with one of the few visible links of the Empire at the Antipodes would be well maintained. He rather trembled when Lord Denman began to refer to some of the confidences which he (Sir George) had given to Lord Denman, because he had given Lord Denman one or two humble suggestions which were entirely unfit for publication. He had been delighted with the paper which Captain Collins had read. He had had many intimate opportunities of knowing the ability and the zeal and the successful manner in which Captain Collins represented Australia both before and since his own time, and he could assure the audience that it would have been really hard for him (Sir George) to stand the strains to which he had been subjected if he had not always had Captain Collins's thoroughly able, loyal, and efficient assistance. He supposed the audience were not at all surprised to hear that his distinguished friend, Sir Edward Hutton, had not agreed on all points with Captain Collins; he did not know any man in the world with whom his friend Sir Edward did agree, except one—and that was himself. He managed to agree with Sir Edward by saying to him: "Do what you like, and I will back you up." He would like to take the present opportunity, from a very intimate knowledge of Sir Edward Hutton, of expressing to Sir Edward, on behalf of Australia, a very profound feeling of gratitude for the great services which he had rendered in the earlier days of that country's military development.

The vote of thanks to Captain Collins was then put and carried.

Captain R. M. Collins, in acknowledging the vote, desired to say that if General Sir Edward Hutton and he did differ at times, at all events he cordially joined in the recognition of the immense services that were rendered by Sir Edward to Australia's defence. The scheme Sir Edward introduced in Australia for military defence would last some considerable time, and form the groundwork on which all future military systems would be based.

Lord Blyth, on behalf of all present, wished Lord Denman and his amiable wife long life and all happiness in their undertaking. He (Lord Blyth) was proud of being in a very small way instrumental in getting Lord Denman to take the chair that afternoon. He had had the pleasure of

meeting Lord Denman in the House of Lords for the past three or four years, and in some respects Lord Denman had been his master there. In the kindest way possible, Lord Denman had always shown members of that House how they should do their duty. Referring to Lord Denman's appointment as Governor of the Commonwealth, he (Lord Blyth) had spoken to several Peers on the side of the House on which he had the honour of sitting, and they all said, "We have got a man who will do his duty and his actions will bear golden fruit," and that expression was also borne out by several members of the Opposition. There was, indeed, perfect unanimity as to what Lord Denman was likely to do in Australia for the Mother Country, and all hoped that he would have health and strength to carry out his high ideals.

The Chairman, in acknowledging Lord Blyth's kind wish, said he was very glad to have had the opportunity of being present that afternoon, because he had met several people with whom he hoped to be closely associated in Australia, and he had also had the opportunity of listening, apart from the address given by Captain Collins, to some of the best speeches he had ever heard in his life.

Mr. C. Reginald Enock, F.R.G.S., writes:—"It is very evident to students of Australian affairs that one of Australia's greatest needs is population. But it is doubtful if the conditions offered to emigrants from Britain, good though they are, will prove sufficient in the future. I venture to urge once more the policy I have advocated; that areas of fertile Crown lands should be set aside for the use of British municipalities, to form properties to be developed by their ratepayers, and as outlets for their surplus population, present and future. The territory of Northern Australia appears to be unencumbered. Why not allocate such areas therein to every British county or city as a perpetual property, and invite capital and settlers thereto? The time will come when such properties would be of great and growing value. Australia and Canada continue to drain away the British land-working element, and to leave us our artisan element which lacks sufficient employment at home. But this process must come to an end from natural causes; whereas, if our home communities were endowed with overseas properties of their own, a field would be provided for the establishing of industries additional to agricultural ones, and a strong tie of possession and interest grow to being between the homeland and Australia. Present conditions of emigration are too hazardous for a great number of people—men and women, to say nothing of boys; whereas if organised conditions, such as suggested, were brought about, it is reasonable to suppose that a far greater number would avail themselves of them."

ARTS AND CRAFTS.

The Reproduction of Sculpture.—After two years' work, Mr. Reynolds-Stephens has brought his improved electrotyping process to such a point of perfection that he was able to show, at his studio the other day, a very beautiful and quite remarkable reproduction of his well-known group, representing Elizabeth and Philip II. of Spain contending for the supremacy of the seas in a game of chess, at which they are using ships for pawns. It is a matter of common knowledge that the reproduction of sculpture by the usual methods is anything but satisfactory: the moulds have to be made in small pieces, and owing to shrinkage and various other causes there is generally a good deal of distortion, so that the charm of a really fine original is inevitably lost. Mr. Reynolds-Stephens has realised the dangers which beset his process and set himself thoughtfully and methodically to overcome them. He made a special plaster model carefully articulated so that it could be taken to pieces for the casting, and arranged so that the joints came in convenient places. From the various portions of this model the gutta-percha moulds were taken. When once they were set, instead of being stretched slightly to get them off —with the natural result that they did not return to exactly their original lines—they were bound with metal to keep them in shape, and then the plaster was simply broken out of them, with no attempt to keep it intact. Thus the moulds, when they came to be fitted together, joined exactly without having to be pulled into place, and the reproduction taken from them by means of a process of electro-deposit of copper, is an exact facsimile of the original piece of sculpture. The sculptor in this case has finished off the group by tinning the damask pattern of Elizabeth's dress, and by inserting pieces of mother-of-pearl, etc., in the trimmings of the costumes, and enamelling Philip's jewel of the Golden Fleece, so that this particular piece of work represents, besides the bare result of the process, a good deal of the artist's own labour and thought; but no one who has seen Mr. Reynolds-Stephens's trial piece can doubt the success of his process or remain unconvinced of the possibility of worthily reproducing sculpture by his new method. It is to be hoped that some proportion of those who will probably see it at the May exhibition of the Royal Academy will realise what it really means.

The Salting Bequest.—All students of applied art who have been in the habit of visiting the Victoria and Albert Museum, are well acquainted with the name and fame of the late Mr. George Salting, but since the bulk of his collection has hitherto been distributed through the museum, probably very few people realised the extent of his bequest to the nation until they saw the whole housed in its new quarters. It is, indeed, a bequest extraordinarily well worth having. The wonderful collection of pottery includes

Henri II. ware, Palissy ware, Italian Majolica, Hispano-Moresque work, Persian and Syrian pottery, and a splendid muster of Chinese porcelain. And pottery is only a fraction of the whole which includes, among other things, really valuable examples of woodwork, *cuire bouilli*, ironwork, ivories, cut jade, lacquer work, and applied art of almost all kinds.

It seems, perhaps, hardly generous to look a gift horse in the mouth, and one can appreciate the feelings of a collector who wishes the world to know the extent of the collection he leaves behind him; but from the point of view of the nation at large, it is a thousand pities that the works of art, which, according to the terms of Mr. Salting's will, are shown at South Kensington in rooms apart from the rest of the exhibits, cannot, after a brief display by themselves, take their place in the general galleries and be included in the ordered sequence of the newly-arranged museum. The present grouping of the objects reflects credit on whoever was responsible for their arrangement, and the plan which places the Chinese and Japanese porcelain on the second floor, rather beyond the end of the main pottery collection, is specially to be commended; but, though this is an excellent expedient under existing circumstances, it is scarcely an ideal arrangement.

All-British Applied Art.—The All-British shopping week offered incidentally an opportunity of seeing a good deal of English industrial art. There was a little exhibition of British lace held in Wigmore Street, under the patronage of the Queen and other members of the Royal Family, at which plenty of good Buckinghamshire, tambour, Honiton, and other laces were shown, though some of the best Devonshire industries were not represented. Good specimens of Lancastrian, Ruskin, Doulton, and other pottery were displayed by a number of shops and dealers, and must have given the man in the street rather a surprise if he stopped to think about them. Waring's exhibited some beautiful examples of brocades and damasks, woven at Spitalfields and Braintree. It would have been interesting to have seen some of these labelled and arranged side by side with French goods, for they certainly looked as if they would compare by no means unfavourably with silks woven at Lyons and Paris. There were a number of pretty prints and chintzes about—and the centre of one of Liberty's windows was occupied by a fine bold pattern called the golden pheasant, block-printed on a specially woven ground. A large number of colours were employed and it could not have taken far short of thirty blocks to print the design as it stood. A *tour-de-force* is not always artistically happy, clever as it may be technically, but this particular effort, which in its way was as fine as a piece of tapestry, was very well worth the trouble taken to produce it.

The Sir John Cass Arts and Crafts Society.—The Sir John Cass Arts and Crafts Society held its annual exhibition at Sloane-street this year, and the exhibits were quite up to their usual high standard. Mr. Harold Stabler, besides some work which had been exhibited elsewhere, showed a very pleasingly-shaped silver ciborium decorated with well-chosen vine ornament. Mr. Kruger sent some admirable decorative sketches, Mr. Gilbert Bayes some charming little statuettes, particularly a tiny knight in armour, which was most attractive; Mr. Manwaring contributed some very satisfactory pieces of lettering and illumination. With these exceptions the show consisted mainly of jewelry, of which there was a very creditable collection. The old Sir John Cass students have, as a rule, much more feeling for design than the ordinary run of school-trained jewelers, and by far the greater part of the objects shown at Sloane-street were well considered and well planned, and had a certain distinction of style which most "art jewelry" lacks. Miss Kirkham exhibited a very attractive clasp, besides a very dainty chain and pendant; Miss Violet Ramsay was represented by a case of work in which the right relation of the stones to the silver work was very well maintained, and Miss Shipwright's chains showed a good deal of fancy in the designing of the links, whilst several other ladies showed interesting work.

GENERAL NOTES.

Loan Funds for Women.—The report of the Society for Promoting the Employment of Women, recently read at the fifty-second annual meeting, over which Lord Balfour of Burleigh presided, contains an interesting account of the year's work of a body which is not so well known as it deserves to be. Established over half a century ago, the society has done admirable work as a pioneer in opening up new professions and occupations for women, and in endeavouring to fit them by systematic technical training for such positions. To assist and encourage girls whose circumstances do not enable them to incur the necessary expenses to secure this training, the society has instituted a series of loan funds. The rules under which they are administered are very simple. The amount of the loans is limited to £30. The grantee, or, if she is under twenty-one, her father, has to sign an agreement that she will complete her training; that she will repay her loan, without interest, after her training is finished, by instalments of three shillings out of every pound she earns; and that she will keep the society informed of her engagements, earnings, and address until the whole of the loan is repaid. Someone in a responsible position must guarantee that she will keep this agreement faithfully. If she fails to do so, the guarantor is responsible for the loan or any portion of it that has not been repaid; but if she is faithful and honest the guarantor is never troubled. The death of the grantee cancels the debt. The first of these loans was granted in 1897, and since that date

there has been an almost constant increase in the amounts granted. For the present year the total is £544, while the repayments amount to nearly £400. It is gratifying to know that it is quite exceptional for a grantee to shirk the responsibility of repaying her loan. As a rule, the instalments are repaid with great regularity, and the extracts from letters which are printed in the report show what a great boon the loans have proved in many cases. Frequently they are the turning-point in a girl's career, and save her from joining the army of unemployables who, while willing to work "in any capacity," are qualified in none. The committee make an urgent appeal for funds to enable them to carry on and extend their work. The appeal was strongly endorsed by Lord Balfour of Burleigh, and there can be no doubt that any money subscribed to the funds of the society will be put to the excellent purpose of helping people to help themselves.

The Galton Chair of Eugenics.—Sir Francis Galton, F.R.S., who died in January last, left his residuary estate to the University of London for the purpose of encouraging the study of eugenics. The residuary estate will amount to some £45,000, which is to be devoted to the establishment of a Chair. The duties of the Professor will be (1) to collect materials bearing on eugenics; (2) to discuss such materials and draw conclusions; (3) to form a central office for the provision of information concerning the laws of inheritance in man; and (4) to extend the knowledge of eugenics by professorial instruction, occasional publications, public lectures, etc. In his will, Sir Francis Galton expressed the desire, though he did not impose it as an obligation, "that on the appointment of the first professor the post shall be offered to Professor Karl Pearson, and on such conditions as will give him liberty to continue his Biometric Laboratory now at University College."

Population of Bosnia and Herzegovina.—The civil population of Bosnia and Herzegovina, according to a census just taken, amounts to 1,895,673 inhabitants at the present time. This shows an increase of 327,501 persons since 1895, or 20·87 per cent.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

April 26.—Noel Heaton, B.Sc., F.C.S., "The Production and Identification of Imitation and Artificial Gems."

May 3.—A. W. Gattie, "London Transport." James Swinburne, M.Inst.C.E., F.R.S., will preside.

May 10.—Hal Williams, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

May 17.—Professor Raoul Pictet, "Les Basses Températures."

May 24.—Frank M. Andrews, "Architecture in America." Sir Aston Webb, C.B., R.A., F.R.I.B.A., will preside.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

April 27.—Sir Thomas Henry Holland, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India."

May 25.—W. R. H. Merk, I.C.S., C.S.I., LL.D., "The N.W.F. Province of India."

Colonial Section.

Tuesday afternoon, at 4.30 o'clock:—

May 9.—F. Williams Taylor, "Canada and Canadian Banking."

Cantor Lectures.

Monday Evenings, at 8 o'clock:—

Alfred E. H. Tutton, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

May 1, 8, 15, 22.

MEETINGS FOR THE ENSUING WEEK.

Wednesday, April 19...Meteorological, 25, Great George-street, S.W., 7.30 p.m. 1. Mr. W. Marriott, "Variations in the English Climate during the thirty years, 1881-1910." 2. Captain C. H. Ley, "The Value of the Two-Theodolite Method for determining Vertical Air-Motion." 3. Captain C. H. Ley, "An Automatic Valve for Pilot Balloons."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. E. J. Spitta, "A Report on the Grayson's Rulings presented by Mr. Conrad Beck to the Royal Microscopical Society." 2. Mr. E. J. Sheppard, "The Reappearance of the Nucleolus in Mitosis." 3. Señor Domingo de Orueta, "Apparatus for Photomicrography with the Microscope Standing in any Position, especially in Inclined Position." 4. Mr. James Murray, "Canadian Rotifers collected by the Shackleton Antarctic Expedition, 1909." 5. Mr. E. J. Spitta, "Low-power Photomicrography with Special Relation to Colouring Methods."

Thursday, April 20...Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Dr. G. H. Rodman, "Stick Insects."

Numismatic, 2, Albemarle-street, W., 6.30 p.m. Mr. G. F. H l, "A Find of Ancient British Coins of a New Ty e."

Friday, April 21...B ewing, Institute of (Yorkshire and North-Eastern Section), Queen's Hotel, Leeds, 8 p.m. Mr. T. Fairley, "The Collection, Composition and Treatment of Water-supplies suitable for Brewing and other Purposes."

Municipal and County Engineers (Metropolitan District Meeting), Caxton Hall, Westminster, S.W., 7.30 p.m. Discussion on the following papers:—1. Mr. A. J. Price, "Pumping Plant for Sewerage and Water Works." 2. Mr. W. Ransom, "Filtration and Purification of Water for Public Supply."

Saturday, April 22...Municipal and County Engineers (Home District Meeting), Town Hall, Croydon, 10 a.m. 1. Mr. George F. Carter, "Some of the Public Works of Croydon." 2. Mr. E. F. Morgan, "Permanent Way and Highways in Croydon." 3. Visits to Public Works.

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FRIDAY, APRIL 21, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, APRIL 26th, 8 p.m. (Ordinary Meeting.) NOEL HEATON, B.Sc., F.C.S., "The Production and Identification of Imitation and Artificial Gems." Principal HENRY A. MIERS, M.A., D.Sc., F.R.S., will preside.

THURSDAY, APRIL 27th, 4.30 p.m. (Indian Section.) Sir THOMAS HENRY HOLLAND, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India." Sir ARUNDEL T. ARUNDEL, K.C.S.I., will preside.

CONVERSAZIONE.

The Society's Conversazione will be held this year at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday, May 30th, from 9 p.m. to 12.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

CHINESE NATURAL PHILOSOPHY AND MAGIC.

By Professor HERBERT CHATLEY, B.Sc.

I.—THE CHINESE THEORY OF THE UNIVERSE.

Within the last few years there has been a rapid assimilation of Western science by the intellectual classes of China, and it may perhaps be feared that, as in Japan, the old knowledge of China is being forgotten. It is, nevertheless, quite demonstrable that the early Chinese ideas as to cosmogony and physics have a basis far sounder than that of the Greek philosophy, which was so long the pabulum of the European scholars. In fact, the dominant idea of mathematical order and relation of effect to cause appears in the Chinese classics in so definite a form that several very striking analogies are presented between the native philosophy and modern science.

The general system seems to have been best described by the sage Ch'u Hsi, who lived in the 12th century A.D. (Sung⁴ 宋, dynasty). According to this philosopher, all things (萬 物 wan⁴ wu⁴, "the manifold") were produced from the Great Absolute (太 極 t'ai⁴ chi⁴, "the ultimate limit") by differentiation into the Yang² (陽) and Yin¹ (陰), which again differentiated and combined into all the countless varieties of things. The words Yang² and Yin¹ are usually translated male and female principles, but would seem rather to mean brightness and shadow, or, in modern terms, positive and negative.

All these changes (變⁴ 化 pien⁴ hua⁴, "metamorphoses") occur in accordance with four principles :—

1. Li³ (理) order.
2. Shu⁴ (數) mathematics.
3. Ch'i⁴ (氣) breath or motion.
4. Hsing² (形) form or outline.

The idea seems to be that each change takes place in accordance with immutable principles (Li³), following mathematical order (Shu⁴), the change proceeding as a motion (Ch'i⁴), and manifested by the form (Hsing²).

If we compare this system with the modern scientific scheme by which things are evolved ("pien hua" seems to mean "evolve" as nearly as possible) from the primitive matter (Crookes' "protyle" or the ether of the physicists) as positive and negative electrons (J. J. Thomson), such changes proceeding according to a regular law expressible mathematically, involving motion and manifest in the phenomena, the analogy is seen to be complete. It may be that the lines of resemblance are stretched

somewhat, but certainly the parallelism is remarkable. The next feature in this extraordinary philosophy is the system of the Kua[4] (卦) figures. The two elemental principles of the Yang[2] and Yin[1] were conceived to have paired in all possible ways, making the four superior Kua[4] (四 象 szu[4] hsiang[4], the four images or stars), which again combined with the elemental forms so that we have eight combinations, each containing three constituent elements (the Eight Diagrams 八 卦 pa[2] kua[4]). These again combined with one another to produce sixty-four "kua[4]" combinations, These sixty-four, each containing six yao[2] (爻) or Yin[1] and Yang[2] elements, produce 384 variations. The order and names of the sixty-four combinations and their mystical symbols are given in the Yih[4] Ching[1] (易 經 = Book of the Change), together with commentaries by various scholars attempting to explain them by ethical and cosmological analogies. Originally there seem to have been three versions of the Yih[4] Ching[1]—the Lien[2] Shan[1] (連 山), the Kuei[1] Ts'ang[2] (歸 藏), and the Chou[1] Yih[4] (周 易), ascribed respectively to Shen[2] Nung[2] (神 農) *circa* 2700 B.C., Huang[2] Ti[4] (黄 帝) *circa* 2600 B.C., and to the founders of the Chin[1] dynasty *circa* 1200 B.C. The Eight Diagrams in their natural order are ascribed to the prehistoric emperor Fu[2] Hsi[1] (伏 羲) *circa* 2800 B.C., who is said to have observed them on the back of a tortoise. Associated with these early speculations are the map of Hê[2] (河) and the chart of Lê[4] (洛), which are composed of numerical arrangement of the Yang[2] and Yin[1]. The notion of the universe as having originally developed from a mathematical arrangement of units appears in philosophical history many times. The essential idea occurs in Lucretius, and is elaborately stated in the cosmogony ascribed to the Pythagorean school (see G. R. S. Mead's book on the Gnostics "Fragments of a Forgotten Faith"). The Sephiruth of Hebrew Kubbalu are quite analogous,* and finally we come on the same idea in Professor J. J. Thomson's recent mathematical theories as to the electronic constitution of the atom.† He shows that the only stable arrangement of the electrons involves a system of concentric polyga (or polyhedra); the number of electrons depending on the degree to which this concentric order is developed. The importance of numerical arrangement in the constitution of matter is also seen in the atomic theory of chemical combinations. Although this analogy between modern science and the mystical speculations of the ancients may not be of any real import, it is rather noteworthy, and would seem to imply that some of the old philosophers intuitively arrived at some of the more important conceptions of experimental physics.

As far as the Kua[4] figures are concerned, it may of course be contended that once the idea of a fundamental duality is conceived (analogous to the main dogma of Mazdaeism), the combinations naturally suggest themselves by mathematical reasoning. Even if this be so, it was certainly a great advance to have conceived that matter is necessarily composed of all the possible combinations of two elements, taken in groups of certain numbers progressively.

The moment, however, we begin to examine the connections which the Chinese sages drew between the combinations and actual phenomena, we find ourselves in the region of empiric or occult reasoning, based purely on analogy. The simple Kua[4] combinations of elemental principles are by them identified with very complex phenomena, with which there is no apparent connection. If we suppose that these phenomena are merely types of those conditions or states which the Kua[4] figures are intended to symbolise, some assistance may perhaps be gained; but it is necessary to be very cautious in making any such assumptions, since the mere desire to magnify the value of these antique concepts may be the mainspring of our action.

In the ode which appears at the beginning of the Yih[4] Ching[1] (周 易 卦 歌 Chou[1] Yih[4] Kua[4] Kê[1]) the eight Kua[4] are said to have made (爲 wei[2]) the eight natural phenomena:—Heaven, Moisture, Fire, Thunder, Wind, Water, Mountains, Earth. (See table on p. 559.)

It is conceivable that originally the diagrams were merely intended to signify the different states of matter suggested in the table, although there is of course the usual objection to this—that concrete ideas generally precede abstract ones.

It seems doubtful whether any useful purpose will be served by endeavouring to identify the meanings of the sixty-four Kua[4] on the same lines; but, presumably, *if* the eight Kua were intended in the manner suggested, the sixty-four extended the system.

* When studied by means of the Gematriyah or numerical system of divination, or the thirty-two "paths" of the Sepher Yetzirah.

† Prout's obsolete hypothesis of atomic constitution is analogous, and indirectly led to Mendeleeff's law, of which Thomson's theory is a development.

The scheme may be shown in a table, as follows:—

Kua[4] Figure.	Name.	Meaning of Name.	Natural Phenomenon.	Possible Significance.
☰	乾 Ch'ien[2]	dry, to come out	Heavens	Change (commencement of).
☱	兌 Tui[4]	to exchange	Moisture (澤)	Permeability.
☲	離 Lí[2]	to separate	Fire	Repulsion.
☳	震 Chên[4]	to quake	Thunder	Vibration.
☴	巽 Sun[4]	mildness	Wind	Equilibrium.
☵	坎 K'an[3]	a hollow, uneven	Water	Heterogeneity.
☶	艮 Kên[4]	obstinate	Mountains	Rigidity.
☷	坤 K'un[1]	yielding	Earth	Plasticity.

II.—Chinese Magic.

The system of occult philosophy upon which magical practices are based in China is practically that outlined in the above sketch of the theory of the universe. The manner in which a series of occult associations of ideas has been formed is described in the following:—

Eitel, "Feng-Shui, or the Rudiments of Natural Science in China." Trübner, 1873 [No. E. 896. Tientsin Municipal Library].

Carus, "Chinese Occultism," in the *Monist* (quarterly review), vol. xviii., p. 510.

De Groot, "The Religious System of China."

The system of magic variously called Feng[1] Shui[3] (風 水) Ti[4] li[3] (地 理), or k'an[1] yü[2] (堪 輿), professes to decide as to propitious times and places, and is more properly termed augury, but as far as the author can discover, the same principles underlie the ritual of the invocation of spirits, divination (prophecy), and thaumaturgy (the working of miracles). At the present time it seems to be only employed in three ways:—

1. The discovery of propitious times and places for the building of houses and the construction of graves. [This depends on an astrological scheme which indicates the *locus* and value of the Yin[1] and Yang[2] at any time or place, and the analogous conditions indicated by the topography.]
2. Fortune-telling.
3. Gambling.

The last-named is generally the final form of a system of divination. The use of cards is said to be derived from the Turot cards which were originally employed for occult purposes. The legend which ascribes the invention of cards to the purpose of amusing a mad king does not seem at all a sufficient explanation, and there is in addition the fact that cards of a kind existed before the said king. In further support of this idea, the well-known practice of telling fortunes by cards may probably be regarded as a survival of a regular form of divination by such means. It seems, in fact, probable that card-playing for stakes is a mere development of a ceremony in which individuals consulting the oracle decided to abide by its pronouncements as to the holding of disputed property.

Dice and dominoes (which are obviously related) serve the same purpose, and are probably related to the Kua[4] Diagrams. The teetotum and the gambling dials used in various games come within a similar category, which includes all arithmetical methods of determining chances.

The occult origin of these games of chance may explain the old ecclesiastical prejudice against them which always had a keen eye for "La magie noire."

The Chinese method of gambling with a number of sticks, such as one sees in Chih-Li, is obviously based on the methods of divination described in the Yih[4] Ching[1]. (In the chapter called 筮 儀 shih[1] i[2], "The Rites of Divination.")*

Divination.

There can be little doubt, when one studies the different forms of divination, that it was the ancient belief that any group of different units whose arrangement after a process of shuffling

* All these sections of the Yih[4] Ching[1] are modern (*i.e.*, written during the Christian Era), but the commentaries on the ancient text, which are of Confucian era, give them logical support.

was impossible to predict would serve for purposes of prophecy, the unseen powers being able to affect the slight variations of circumstance which determine the final configuration, while those initiated into the code explaining all the possible configurations were thereby able to interpret the will and knowledge of the unseen powers. In various occidental and oriental books on occultism, the diviner is directed to concentrate his attention on the object to be known, presumably so that he should become a responsive medium to the spiritual influences, who would so control his nervous and muscular actions that in the process of shuffling a prophetic configuration of the units would be produced.

In the above-mentioned chapter of the Yih[4] Ching[1], after elaborate preparations of the place in which the divination is to be performed and the burning of incense, a conjuration has to be recited and then by a process of shuffling fifty sticks into two or three groups, and counting out the odd sticks by cycles of eight, the two parts of one of the sixty-four yao[2] are determined. The sections of the Yih[4] Ching[1] which explain (!) the meanings of each of the yao[2] are then to be consulted, and the oracular reply is in accordance therewith.

A critical examination of the early forms of the Chinese characters referring to occult practices show that the Tortoise-shell (which is now a figure of speech for the Pa Kua, but anciently was used in the same manner as shoulder-blades, being scorched and its cracks and marks examined) and stalks have from times immemorial been employed to divine the future. The distinction of lucky and unlucky into "Straight or whole," and "Broken or crossed," also shows the antiquity of the Yin and Yang figures.

With regard to the Kua system of divination, it is one of the simplest and most scientific (if such a word is appropriate) of all the systems employed by the higher civilisations. It recognises *ab initio* that circumstances can only combine according to the mathematical law of permutations, and carefully tabulates all the possible results for eight units. By means of stalks or counters the prophetic configuration is simply found and the book of oracles consulted. From a psychological point of view four aspects of this process present themselves:—

1. The shuffling is wholly controlled by chance and the oracle bears no relation to the events concerned.

2. The shuffling is manipulated by the conjurer and the oracle bears a relation determined by his mind.

3. The shuffling is controlled by the subconsciousness of the operation, so that the relation of the oracle to the event is determined by the "infra-mind" or "subliminal self." *

4. The shuffling gives opportunities for extra-carnate beings to influence the nervous system so that the fingers are controlled to produce an appropriate configuration and prophetic oracle. According to magical dogma, this would necessitate the prior production of a receptive and passive state of mind in the operator such as would doubtless follow from an adherence to the ritualistic instructions of the Yih Ching.

Which of these occurs in any particular case may be left open to discussion.

Dr. Carus has suggested that the Judaic Urim and Thummim were of a similar character to the divining stalks. Certainly the divining arrows of Hezekiah are analogous. It is possible that the Jewish priests had a book of oracles similar to the Yih Ching, which interpreted the different groupings of the oracular symbols. The Babylonian text-books (or bricks) on omens indicate a similarly systematic arrangement of oracles. Possibly the Roman Sibylline books also served such a purpose.

Invocation of Spirits.

In an essay by the author on "Mediæval Occultism," published in the *Monist*, an attempt has been made to demonstrate that magical or religious ritual is a form of "suggestion." As a corollary, it follows that the whole of a magical ceremony is a species of auto-hypnosigenesis culminating when successful in a state of ecstasy, which differs from the usual comatose condition in that the operator retains some control over himself. On this hypothesis, the invocation of spirits (conjuration) consists of the following parts:—

1. A preparation of the mind, generally extending through years, which forms a belief in the existence, order, and nature of the spiritual world.

2. A specific preparation of the mind and body for the particular ceremony, generally consisting of a course of abstinence and meditation.

* This of course contradicts the scholastic dogma "Q Nihil est in intellectû quod non prius est in sensû," but modern psychology casts grave doubts on the literal accuracy of this aphorism.

3. A ceremony consisting of a ritual and conducted in such a place that every detail of environment, conduct, and thought, tends increasingly to suggest the desired thaumaturgic result.

Whether such a result accrues or not (*i.e.*, within the subjective experience of the operator, but with the appearance of objectivity) depends on the thoroughness of the preliminary training, the temperament of the individual, and the nature of the extraneous circumstances under which the ceremony is performed. It necessarily involves mental strain, and may lead to madness. [This possibly explains why many primitive races have considered lunatics as divinely possessed, seeing that in such a state of civilisation madness would probably be more frequently induced by this cause than any other.]

We may then divide the consideration of Chinese exorcism (this word really means "casting out spirits," but has come to mean invocation also) into three parts:—

1. The beliefs as to the world of spirits.
2. The rules for the life of a magician.
3. The ceremonies of an act of exorcism.

Beliefs.

In all religions we usually find the spirits arranged in a kind of hierarchy, and their attributes and rank are functions of their position in this hierarchy. The circles of angels described by pseudo-Dionysius-Areopagiticus as inhabiting the Christian Heaven, and the scheme of Buddhas, Bodhisatvus, and Manusibuddhas which appear in the Mandala or world-scheme of Northern Buddhism, are good examples of this idea.

The native Chinese system of spirits, as far as it can be separated from Buddhist influences, does not show any very great regularity.

There seem to be three great classes of spirits:—

神 shen^2, usually translated spirit.
鬼 kuei^3, usually translated devil or ghost.
仙 hsien^1, usually translated fairy or jinnee.*

The three characters seem to be very ancient, and are of a simple formation. The first, 神 shen^2, appears to be the "suggestive compound" type, consisting, as it does, of the two parts 示 shih^4, "to reveal," and 申 shen^1, "to expand."

The second, 鬼 kuei^3 is a radical, and is probably a hieroglyphic. It is rather interesting to notice in this connection the Buddhist character 甶 fu^2, which means a "devil's head." It is, doubtless, not necessary here to point out that the word "devil" is not to be taken in a European sense, but simply as meaning a spirit of less stability than the shen^2.

The third, 仙 hsien^1, is again apparently a suggestive compound, consisting of 人 jên, a man, and 山 shan, a mountain. The association of a kind of elemental spirits with mountains occurs in the folk-lore of all countries. (*Cf.* Arabian "Jinn" of Mount Kâf, and the spirits of the Hartz Mountains.)

The words 神 shen and 鬼 kuei are also used to signify the animus and anima of human beings, *i.e.*, the immortal and astral parts of the human economy. This, of course, falls in well with the doctrine of apotheosis.

Some details of the system are to be found in the Guide to the Musée Guimet of Comparative Religions (Paris), compiled by M. L. de Milloné, Professor J. J. M. de Groot, Terrien de Lacouperie, and Tcheng-King. There we find:—

1. The Trinity of Divinities of Fortune:—

福神 Fu^2 shen^2, presiding over rank and honours.

祿神 Lu^4 shen^2, presiding over emoluments and generation.

壽神 Shou shen, presiding over longevity (identified with Lao-Tze).

2. The Eight Spirits (八神 pa shen^2):—

鍾離 Chung^1-Li^2.*
曹國舅 T'sao-kuo-chiu.*
張果老 Chang-kuo-lao.*
藍采和 Lan-tsai-ho.*
何仙姑 Hô-hsien-kû (fem.).*
呂東嵒 Lü-tong-pin^3, worshipped under name of 純陽 Ch'un^2 yang^2 (Pure principle).
韓湘子 Han-hsiang-dzu.
李鐵拐 Li-tieh-kuai.

All these eight are supposed to have once lived on earth, and during their terrestrial existence practised asceticism and performed great miracles.

Chung-Li was a general of the Han dynasty, and retired during a military expedition to Thibet to become a hermit in the mountains. Ts'ao-kuo-chiu is also said to have lived as a hermit, mortifying himself for the sins of men. Lan-tsai-ho, after a life of austerity, is said to have been translated to heaven without dying. Ho-hsien-kû was a woman, and is said to have had the power of miraculously moving from

* See also animal spirits referred to later.

* These are nominally Taoist, but the Guimet authorities regard them as aboriginal.

place to place. Lü-tong-pin was a great scholar and a Taoist writer; under the instructions of Chung-Li he became a great exorcist. Han-hsiang-dzu is credited with many miracles, and Li-tieh-kuai is said to have died by mischance during a projection of his spirit from the body. Chang-kuo-lao is, like Balaam, principally noted for the possession of a miraculous donkey.

There is yet another Triad of Gods of the Hearth :—

觀 音 Kuan^1-yin^1, protector of children.

Tou-ti-Kung or Ko-lung, god of wealth.

Tsao-Kung-Kung, god of fire and the domestic hearth.

These three deities figure in the ancestral hall to the right of the tablets.

We have again Seven Gods of Luck (七 福 人 ch'i fu jen), to whom special importance is attached in Japan (Shichi-fuku-jin).*

Finally, there are a number of special deities with different functions.

西 王 母 娘 娘 Kin-mou or Si Wang-mou, goddess of the Kuen Lun Mountains. [The Heavenly Mother of the West.]

Shin-to, god of doors.

Huan-ming, god of winter.

城 隍 Ch'eng-huang, generic name of the two protectors of towns, of whom one (the Sing ong ya) guards walls and moats of walled cities, and exercises surveillance over the actions of the inhabitants, and acts as agent for Yên^1 lo^1-wang^2, the Buddhist god of death (閻羅王).

關 帝 Kuan^1-Ti, god of war.

Doubtless many of the Taoist divinities are really native gods, but it is difficult to separate them. The supreme deity, 皇 天 上 帝,† Huang^2 T'ien Shang Ti, the celestial prototype of the Emperor of the 天 下 (T'ien Hsia), figures in both Taoism and Confucianism, but more generally it would seem to be impossible to discriminate between this god and 天 T'ien, which signifies the sum total of the heavenly influences.‡

As in India and Egypt, there is a strong local character about the spirits, the importance of such apparently varying inversely as the extent of their influence. Primarily we have the ancestral spirits (神 主 shên^2 chu^3, spirit-lord), or (祖 宗 tsu^3 tsung^3), commonly translated "ancestors," but apparently having a hieroglyphic meaning of "the numerous (且) watchers (示) of the home" (宀, a roof). Secondarily, we have the three gods of the hearth above referred to. Thirdly, there is the local god (土 地 神 t'u ti shên). Fourthly, occur the Ch'eng Huang (literally Town Moat*), mentioned above. Fifthly, we have the gods of special localities, who are probably developments of the 大 社 ta^4 shê^4, the tutelary deities who influence land and agriculture.

Superimposed on this animistic system, we have the literary cult of the philosophers in its Confucian and Taoist forms, the saintly hierarchy of the Buddhists, and the imperial worship of the heavenly and earthly influences. The last seems to be an intensification of the local rites, the Emperor acting as the Chief Priest of the country in the same way as the senior male of the household does for the family. In connection with this, the ceremony of ploughing, performed by the Emperor annually at the capital, bears a close analogy to the sacrifices, human, animal and symbolic, made by many primitive races in connection with agriculture. According to Wells Williams ("Middle Kingdom," pp. 108 and 99), on the occasion of this imperial ploughing, a large clay cow, accompanied by or containing numerous small images of a cow, is broken up and the fragments are distributed over the fields. A similar ceremony is performed in each of the provincial governments. Williams gives the following references in support of this:—"Penal Code," pp. 94-106, 526; "Chinese Repository," vol. ii. p. 350, vol. iii. pp. 121, 231, vol. v. p. 485; "La Chine Ouverte," p. 346; and "Foreign Missionary Chronicle," vol. xiii. p. 296.

There is yet another type of spiritual influence which is greatly credited in the Chinese Empire, and is apparently endemic, namely, the animal-demon. Chinese fiction and legend abounds with the exploits of these supernatural beings, who possess the power of metamorphosis from animal to human forms, and *vice versa*. These are generally known as 狐 hu^2, or witch-forces. The notion of the transformation of sorceresses into animals is quite widespread, and there are

* The most popular is 財 神 T'sai^2 shen, the spirit of wealth.

† Or 玉 皇 上 帝 Yü Huang Shang Ti, the present ruler of the universe. [The Precious Imperial Exalted Ruler.]

‡ All these divinities, regardless of their present celestial rank, are identified with deceased men and women, and it would doubtless be more correct to specify the Chinese hierarchy as a system of official ranks at present occupied by souls of these names. The cult varies from mere formal respect in pure Confucianism to absolute worship in the lower forms of Taoism.

* It would be interesting to know if in ancient times these town gods were created by human sacrifice, as in other countries was the case.

particularly strong associations with canine animals. The witchcraft literature of Europe contains repeated references to the metamorphosis of witches into foxes and *vice versa*, and the Eastern European beliefs in the were-wolf and the vampire are analogous. This class of spirits is known to European occultists as "familiar," and is apparently less noxious than the devil tribe.

In China the spirits may be arranged in the following order:—

神, 仙, 狐, 鬼, Shen, Hsien, Hu, Kuei.

The 神 Shen, and 鬼 Kuei, are the two poles of beneficence and maleficence respectively, and the intermediate varieties are respectively good and bad elemental spirits. In terms of the human economy, the 神 Shen, would seem to stand for the highest faculties, the 仙 Hsien, for the pure and pleasing emotions, the 狐 Hu, for the spirit of mischief and irresponsibility, and the 鬼 Kuei, for the darker passions and blackest depths of the mind. These conditions projected by the imagination on to the fabric of thought (the occultists' "Astral Light"), give rise to the conceptions of spirits of all these types.

It is very noteworthy that all the supernatural beings of Chinese mythology are believed to have been originally living men or women, so that the system is perfectly animistic.

Astrology.

In addition to these personal deities, to whom (unless they be immediate ancestors) no great respect is shown, we have a number of natural forces based on the astrological exposition of the Yih Kua system. In accordance with the first law of Li[3], the heavens control the earth and its inhabitants. The exact manner of this control gives rise to a system of astrological parallels. The "four figures" are symbolised in the heavens by the Sun, Stars, Moon and Planets.

太陽 T'ai Yang is the name of the Sun.

少陽 Shao Yang is the name of the Fixed Stars.

太陰 T'ai Yin is the name of the Moon.

少陰 Shao Yin is the name of the Planets.

It is somewhat curious that the Yang bodies are those which we now know to shine by their own light, whereas the Yin bodies are those which shine by reflected light, but probably the discrimination was made on account of the invariability of the light of the Sun and Stars as compared with variability of the light of the Moon and Planets. The apparent daily rotation of the Sun is also symbolised by the Fu-Hs arrangement of the Kua, in which the Chien Figure (☰) takes the South position, and the K'un[1] (☷) the North, the Li[2] (☲) takes the East, indicating the predominance of Yang (light) over Yin (darkness) as typified by the rising of the Sun, and the K'an[3] (☵) figure takes the West, indicating the predominance of darkness (Yin) over Light (Yang) as typified by the rising of the Sun; the Tui[4] (☱) in the S.E. and the Sun[4] in the S.W. (☴) respectively indicate the increase and decrease of Yang (Light) as typified by the ascent and descent of the Sun, and the Chên[4] (☳) in the N.E., and Kên[4] (☶) in the N.W., respectively indicate the decrease and increase of Yin (darkness), typified by the ascent and descent of the Sun to and from its Northern depression. This arrangement is of course only applicable to the Northern Hemisphere of the Earth, and serves to explain the fact that the Chinese compass-needle points *South* (*i.e.*, in the direction of the Sun's meridian culmination, the region where Yang is supreme).

The annual apparent revolution of the Sun is illustrated in the Chinese year and the division of the Ecliptic into twenty-four parts (each of 15°), in each of which the Sun has a different meteorological influence, so that the famous agricultural calendar is divided into fortnightly periods, each characterised by certain climatic features.

The motion of the Moon is also shown by the division of the Ecliptic into twenty eight houses or constellations, each of which corresponds to its path during one day. The affinities between these and the particular effect each has on the Moon's influence is shown by symbols in the "lo-pan" or magician's compass, the affinities being expressed by the natural relations of the five Chinese elements. The Indian system of the twelve signs of the Zodiac does not seem to be indigenous to China, and was probably introduced by Buddhist priests, or by the Jesuit astronomers.

The next most important feature in connection with astrology, is the famous dragon of China (龍, lung[2]). The character representing this creature is one of the radicals, and both for this reason and also from its appearance we may regard it as a primitive hieroglyphic. This, together with the mystical references to the dragon in the Yih Ching, clearly shows that it

is a very ancient conception. The present form, as shown in pictures, etc., is familiar to all, and it is rather noteworthy that it is almost identical with the mythical dragon of European romance (compare the pictures of St. George and the Dragon, or the description of the Dragon in the Legend of the Island of Rhodes). Some more detailed idea of the native conception can be obtained by noticing the words written with this character lung² as the radical:—

龕 K'an¹, a shrine for an image.

龔 Kung¹, decorous.

龐 P'ang², great house, confused.

寵 Ch'ung², grace.

These are all, apparently, composite words, indicating respectively dragon-shrine, dragon-net, dragon-house, implying royalty and magnificence in each case.

Some of the words having this character as a *phonetic* seem to be composite, and so contain some idea of the attributes of this creature.

Lung² 儱, rude, unpolished (Dragon-man); 爖, to kindle a fire (Dragon-fire).

朧, rising moon, obscure (Dragon-moon); 籠, a cage, snare (Dragon-bamboo).

櫳, a pen, cage (Dragon-wood); 聾, deaf (Dragon-ear); 曨, rising sun obscured (Dragon-sun).

Lung³ 壟, mound, monopolise (Dragon-mouth); 攏, grasp (Dragon-beat); 竉, hole (Dragon-cane).

Also 襲 hsi², Dragon-clothed, hereditary.

Throughout all these there seems to be the idea of a mysterious, reserved, but royal and omnipotent power. We notice, moreover, that there is some relation to the Sun and Moon, as we have the two words 朧 and 曨, respectively meaning a rising or obscure moon and sun. Add to this the general idea that during an eclipse (日 蝕, jih⁴ shih², sun eaten away as by an insect, or 月 蝕 yüeh⁴ shih², moon eaten away) a mysterious dragon consumes the luminary, and that the imperial device of China is a dragon chasing the sun, and it is evident that there is some astronomical or solar-myth reference. It is conceivable, as far as the phenomena of eclipses are concerned, that the mysterious dragon was supposed to eat away (蝕 shih²) the sun or moon just as an insect gradually eats away a leaf with a circular cut. There are, however, other references which increase the connection with soli-lunar phenomena. The nodes of the moon's orbit (*i.e.*, the apparent points where the moon's path crosses the Ecliptic) are known to European astrologers as the Dragon's Head and Tail (written symbolically ☋ and ☊ in the almanacs); and in India there is a belief in two mysterious beasts, Rahu and Kethu, who have an intimate relation to eclipses, are regarded as two invisible planets, and are in fact the same two points, the moon's nodes. The fifth constellation of the Chinese Zodiac is also called the Dragon, but since it is only one of twelve animals it would not seem to have any special meaning here; moreover, this system of naming the parts of the Ecliptic is not much used, the titles being confined in their use almost entirely to the compound nomenclature of the sexagenary cycle. It will be remembered that the Dragon is one of the original twenty-eight constellations in the Greek catalogue of Ptolemy and Hipparchus, but this group of stars is near the Pole and cannot be regarded as having any appreciable connection with solar phenomena. The dragon occurs again as one of the two terrestrial breaths (Ch'i), or currents, named respectively the Azure Dragon 青 龍 Ch'ing Lung², having the nature of Yang, and the White Tiger 白 虎 pai hu³, having the nature of Yin.

The complete identification of the Dragon with the Yang principle appears in the first Sibylline verse of the Yih Ching, which deals with the double Chien kua, Yao (☰).

First line. 潛 龍。勿 用。
Chien lung. Wu yung. Reserved dragon. Not employed.

Second line. 龍 在 田。利 見 大 人。
Lung tsai tien. Li chien ta jen. A dragon in a field. It is an advantage to perceive a great man.

Third line. 君 子 終 日 乾 乾。夕 惕。若 厲。无 咎。
Chün-dzu chung jih chien chien. Hsi t'i jê. Li. Wu chiu. The chien figure is the time of the consummation of a superior man (or of the prince). As if lately become useful. Severe and just.

Fourth line. 或 躍 在 淵。无 咎。
Huo yüeh tsai yüan. Wu chiu. Perhaps he leaps into the abyss. No fault.

Fifth line. 飛 龍 在 天。利 見 大 人。
Fei lung tsai tien. Li chien tu ren. A flying dragon in the sky. It is an advantage to perceive a great man.

Sixth line. 亢 龍 有 悔。
K'ang lung yu hui³. The overbearing dragon has repentance.

The whole group. 見羣龍无首。吉

Chien ch'ün lung wu shou chi. Behold a multitude of dragons without a leader. Fortunate.

The oracular character of this is in no way reduced by the official commentaries, save that one line of analogy to cosmical phenomena is suggested, and a second of analogy to the ethical doctrine of Confucianism. However, it seems fairly clear that the royal, energetic and mysterious or reserved dragon typifies the active light-producing male principle. The different lines (figures in the kua, Yao) seem to imply an increasing degree of activity having diverse results. First, we have the power of the dragon as it were latent. Secondly, it becomes apparent. Thirdly, it reaches consummation. Fourthly, there is a suggestion of instability. Fifthly, an alternative of predominance is suggested; and sixthly, a moderation of energy. The whole group is regarded as a concatenation of energy without definite outcome, and it is fortunate, presumably, in that it contains boundless possibilities.

Another apparent relation of the Dragon to Solar mythology occurs in the Dragon-Boat Festival (fifth day of the Fifth Moon) and the Festival of the Dragon-God (tenth day of the Fifth Moon), which approximately coincide with the Summer Solstice. The power of Yang (Light) is of course at a maximum when the sun is at its maximum elevation (夏至 Hsia chih).

It is doubtful where one might dare suggest that the character is not a simple one, but that it consists of 立。月, and an archaic form 𢀖, the last being the actual hieroglyphic for the Beast himself, so that there is a sense of the Beast who sets up or establishes (立 li) the moon (月). This would agree very well with the notion of the dragon as the symbol of the moon's nodes.

Other mystical beasts are the following:—

麒麟 ch'i² lin², the unicorn.

鳳凰 fêng⁴ huang¹, the phœnix.

Both these seem to be associated with meteorological phenomena. The first is a quadruped with the attributes of a deer (as shown by the double use of the radical 鹿 lu⁴). The second is a bird (as shown by tradition and the radical 鳥), but the double use of the 几 feng form evidently indicates a connection with the wind, while the use of the 皇 gives a suggestion of royalty. In spite of the absence of the phonetic use of fêng in the first character, the dictionaries regard 几 (No. 10 radical) as the radical for the second character. This would seem to be open to question.

Yet another phase in the spiritual belief of China is the Tao (道) conception, which finds its principal expression in the Classic of the Virtue of the Tao (道德經) of Lao Tze (老子), and also pervades the Confucian scheme of philosophy to some extent. The essential idea seems to be a pantheistic one analogous to that of the Logos doctrine and of the Atma of Vedantism, but the Taoists appeal to its miraculous force in thaumaturgic operations.

Rules of Life.

There seems to be a strong tradition in favour of asceticism as a means of inducing psychological powers. Taoists and Buddhists agree strongly in this respect, and although Confucianism attaches prime importance to book-learning, it also would seem to favour ascetic means of acquiring knowledge. Thus Wen Wang's (文王) mystic interpretation of the Yih Kua was the fruit of his enforced seclusion in prison. There can be little doubt that a prolonged abstinence and concentration of ideas does tend to produce an ecstatic state in which visions and other apparently supernatural phenomena occur. Whether such are purely subjective or not is a matter which we are not here called upon to discuss. [It is, however, noteworthy that similiar but more awful results are produced by excessive intemperance, so that the fantastic dreams of delirium tremens, opium and bhang intoxication are frequently regarded as forms of black magic. The medieval instructions for witches in Europe contain excessive intoxication as an essential feature.]

Magical Ceremonies.

The ritual of Chinese occultism shows strong signs of a Shaman origin. The use of a drum or gong, incense, and the development of a condition of hystero-epilepsy, are all features which Chinese and Shaman cults have in common.

In the Rev. McGowan's recent book, "Side-Lights on Chinese Life," pp. 246-7, there is a description of the initiation of a priest which strongly resembles the ceremonies of the Finn sorcerers or the Bon-pa Lamas of Thibet. It reads as follows:—

"A certain weird ceremony is performed in front of the god during some dark night, when only a candle or two shows the idol surrounded by the mystery of darkness. Incantations are slowly chanted, and invocations made to the wooden image to inspire the man that stands

motionless in front of it. The tap of a drum now and again acts as a kind of bass note to the higher notes of the reciter of the vague and mystic language that is supposed to move the idol to a manifestation of its will.

"After an hour or two of this monotonous dirge and occasional tapping of the drum, which is evidently meant to quicken the decision of the god, the man who has been as silent and motionless as a statue begins to sway slightly from side to side. The taps on the drum now become more rapid and more vigorous, and ere long the wretched man becomes convulsed and falls on the ground as though he were in a fit.

"The scene is ended and the god, it is believed, has entered and taken possession of the man, and now whenever he speaks officially he does so as its inspired oracle, and his utterances are accepted as though they had been spoken by the idol itself."

Disregarding the deprecatory remarks of the reverend narrator, the following points may be noted:—

1. There is a definite ritual.

2. An environment of the most impressive character is arranged.

3. The subject remains as motionless and passive as possible.

4. The drum is beaten at intervals. This would have a hypnotic effect like the ticking of a watch or clock.

5. The ceremony is prolonged so that the nerves are continuously excited and fatigued.

6. Presently the subject begins to have automatic motion or convulsion. This is a common feature of these performances. Compare the symptoms shown by the Darweeshes in a Zikr (Lane's "Modern Egyptians") and the hysterical excitement of a revivalist meeting.

7. Finally the man recovers with a mind changed in certain respects.

It should be clearly noted that the part played by the god in this ceremony is assumed throughout by the writer of this account, and is not necessarily even supposed to be as described by him. It appears to the author more probable that the obsession is believed to be that of an inferior spirit, or it may be that actual obsession is not believed to occur but only that a state of spiritual communion with the god is produced. It is certainly very improbable that the spirit is absolutely identified with its image in the manner Mr. McGowan assumes.

TECHNICAL WORDS RELATING TO MAGIC.

念呪 nien chou⁴, to chant an invocation.
鬲 li⁴, an incense cauldron or censer.
香 hsiang¹, incense.
夢 meng⁴, vision, dream.
Ditto with 兆 (meng⁴ chao⁴), prophetic dream.
壇 t'an², altar.
Ditto with 祭 chi⁴ t'an², sacrificial altar.
禳 jang², fast and pray to avert evil.
佟 t'ung², a sorcerer.
覡 Chi⁴, a necromancer.
呼龥 Hu¹ yü⁴, to invoke.
逐鬼術 chu² kuei³ shu, exorcism (expulsion of a spirit).
畫符 hua⁴ fu², to make pictorial charms.
幻術 huan⁴ shu } spiritual magic.
妖術 yao¹ shu }
巫術 wu shu } sorcery.
怪術 kuai⁴ shu }
見神鬼 chien-shen-kuei, to see spirits.
遠見力 yuan-chien-li, clairvoyance.
預言 yü yen, prophecy.
咒訣 chou⁴ ch'ui², conjuration.
拜 pai⁴, worship.
敬 ching⁴, revere.
偶像 ou³ hsiang⁴, sympathetic image.
鬯 ch'ang⁴, sacrificial bowl (also 俎 tsu³).
鼎 ting³, sacrificial tripod.
肵 ch'i², sacrificial tray.
庵 an¹, an oratory.
占 chan¹ } to divine.
筮 shih¹ }

KENTUCKY ROCK-ASPHALT AND ITS USES.

This material, which is a siliceous sandstone containing from 5 to 25 per cent. of bitumen (maltha), is found in the upper beds of the sub-carboniferous formation, locally known as Chester sandstone. The latitude is 37° 15′, longitude 86° 15′, ten miles west from the celebrated Mammoth Cave. It is a rather fine-grained, sharp siliceous sandstone, each separate grain of which is entirely coated with bitumen to the extent of 8 to 15 per cent. The commercial product must contain at least 8 per cent. The sand is quite hard, probably as high as 7 per cent. in the scale of hardness, hence its durability as a road material. It is found in rather irregular beds or pockets, ranging in thickness from five to twenty feet, much of which can be quarried in open cut, and therefore at little expense. It is evidently the oxidised product of petroleum. It

is prepared for use on roads and streets by passing through a jaw-crusher, then through two sets of rolls eighteen inches in diameter by two feet in length, when it comes out with each grain separate and distinct, and ready to be spread cold on the prepared macadam surface to a depth of two inches, when it is sufficiently rolled, chiefly for the purpose of pressing it into the interstices of the broken stone. It is now ready for traffic; indeed this is never stopped. When freshly crushed it is of a rich, dark colour, with a slight lustre which gradually disappears as the bitumen dries and hardens.

The following may be taken as the specification for the use of the material:—"Shape and roll the roadway, then place and roll a six-inch layer of stone broken to pass through a two-and-a-half-inch ring. On this place a second layer of one-inch stone, and, before the latter is rolled, spread thoroughly and uniformly two inches of cold (uncooked) rock-asphalt. Roll thoroughly and the road is ready for traffic."

The Federal Government made a test of this material in August, 1907, upon a twenty-feet Telford road bed, which was repaired and brought to grade by means of four inches of broken stone. This course was rolled once to turn down the sharp edges and to form an even surface. No attempt was made to fill the voids, as these were to receive the rock-asphalt, which was spread to a depth of one and a half inches, care being taken to crush all the lumps and to work it into the voids of the stone without disturbing the latter. One half of the roadway was worked while the other was left for traffic. The cost of this work was 47·63 cents per square yard. The finished road surface was similar to the ordinary artificial asphalt pavement in its dark brown colour and smooth, even finish.

The Federal highway engineer in charge of this experiment says:—"The permanence of macadam construction depends largely on the nature of the binder used, and the ability of traffic to supply by attrition the material which is removed by wind and water. It was to test the rock-asphalt as a binding material that this construction was made. The pavement formed is *dustless*. There is no appreciable wear of the surface to be raised by the wind and carried away by the rain, or removed by sweeping or flushing with water. There is sufficient adhesive power in the bitumen to serve as a cement to hold the stone of the wearing-course in place, giving at once a smooth and *waterproof* surface. It is resistant to deformation under a load, yet sufficiently plastic to break the severity of the blow from the hoof of the horse, and thus in a measure avoid the harmful effects of rigid pavements on animals."

The report of inspection for the Federal Government of the above road says:—"After a searching inspection made after the fourth winter the surface is in perfect condition—as good as when first laid."

In addition to road material a mastic is made by using 75 per cent. of crushed rock-asphalt, 20 per cent. of ground limestone, and 5 per cent. of pure bitumen. This is heated to a temperature of some 250° F., and moulded into 50-lb. blocks, and finds a ready sale for waterproofing breweries, subways, etc. The cost of surfacing macadam streets and highways is ten to twenty cents per square yard higher than ordinary macadam. This material has passed the stage of experiment, and many thousands of square yards are being laid annually.

MALCOLM H. CRUMP, C.E.

THE SUGAR-PALM OF THE EAST INDIES.

The Sugar-palm (*Arenga saccharifera* of botanists) grows abundantly in all the Dutch East Indian islands, and provides the natives not only with a fermented beverage termed *sagueiro*, but with sugar, cordage for the rigging of praus and material for caulking them, and brooms for sweeping. The palm is called *pokko gamutu* by the Malays, and plenty of the trees are always found in the neighbourhood of the villages. One of the commonest daily sights in a Malay village is the bringing

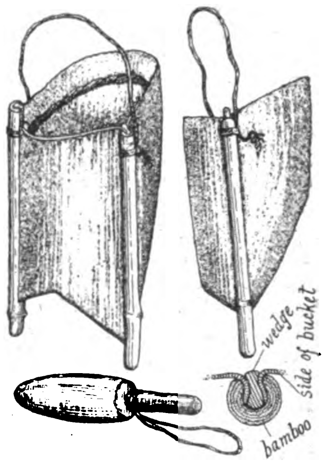
SUGAR-PALM.
(*Arenga saccharifera.*)

home, slung over the shoulder, of the large bark buckets full to the brim of sagueiro, the liquid frothing on the top and of a milk-white colour, its fluidity also resembling that of milk. The palm itself is a fine though rather rough-looking

tree, bearing huge bunches of fruit composed of large orange-coloured berries, the male inflorescence being then over, but the withered remains form similar large bunches of what at first sight look like strings of small dark purple or black berries. It is the stalk of the male inflorescence only which is tapped for the sap, and as the bunch is very heavy and also bears the weight of the sagueiro bucket, it is generally supported against the trunk by a stout prop. The palms produce fruit more or less throughout the year.

When about to tap the tree, the native usually climbs up by means of a long bamboo lashed against the trunk of the palm, just the bases of the bamboo boughs being left to form rungs or steps. He then bruises the flower-stalk with a heavy wooden pestle on all sides and from end to end, likewise swaying and twisting the bunch to loosen and disintegrate the fibres of the stem, or "make the sap flow," as the native says. Then a small nick is cut on the underside of the stem and a bucket is slung below. The tapping is done in the evening as a rule, and the sap trickles into the bucket all night, sometimes producing fifteen litres, or a little over three gallons by the time the native fetches the bucket in the early morning. During the day (say the natives) the sap practically ceases to flow, and when the bucket is taken away a leaf is tied around the wound in the stem to prevent the sap from dripping. Sometimes if there is not much sagueiro in the bucket it is left for another night on the palm, and a mass of bast from the leaf-sheaths is put over its mouth during the day to keep out sun, rain and insects—for there is always some slight drip from the buckets, and these and the jungle beneath are usually swarming with insects, all eager to lick up the sweet juice. Flies, bees and wasps are the most numerous, but many beetles and butterflies are attracted; it is in the sagueiro buckets that the large beetle with extraordinarily long forelegs (*Euchirus longimanus*) is frequently found by the natives of Ceram and Ambon, having fallen in whilst drinking the sap. One flower-stalk will often give sap for two to six months, and as one stalk fails another comes to maturity; the life of a palm being tapped regularly is said to be fifteen to twenty years. Occasionally one may observe a wasted and blackened palm which has been bled to death by tapping. The sagueiro is either drunk fresh, when it has a sweetish taste, or more often small pieces cut from the living roots of a large tree, heavy and very bitter wood of a brightish yellow colour, are put into the liquid. This makes a very refreshing drink on a hot day, and is sold very cheaply at all the wayside huts and villages. It is quite possible to become inebriated with fermented sagueiro or "palm-wine" if large potations are indulged in, though one but rarely sees a tipsy native. Nor does it produce the fighting and quarrelling that beer and spirits provoke, and these intoxicants are strictly prohibited by the Dutch Government from being supplied to the natives.

The sagueiro buckets are large—about eighteen inches deep, and, roughly, about ten in diameter—and are made of the inner part of the leaf-sheath of the ever-useful sago-palm. A long rectangular piece of sufficient length to form the two sides and the bottom of the bucket, and broad enough to make the desired diameter, is shaved down till it is about an eighth of an inch thick, and is softened by soaking in water; four slight cuts, forming a lozenge or diamond, are made at mid-length, the two ends are bent up to form the sides of the bucket, and their edges are thrust into two

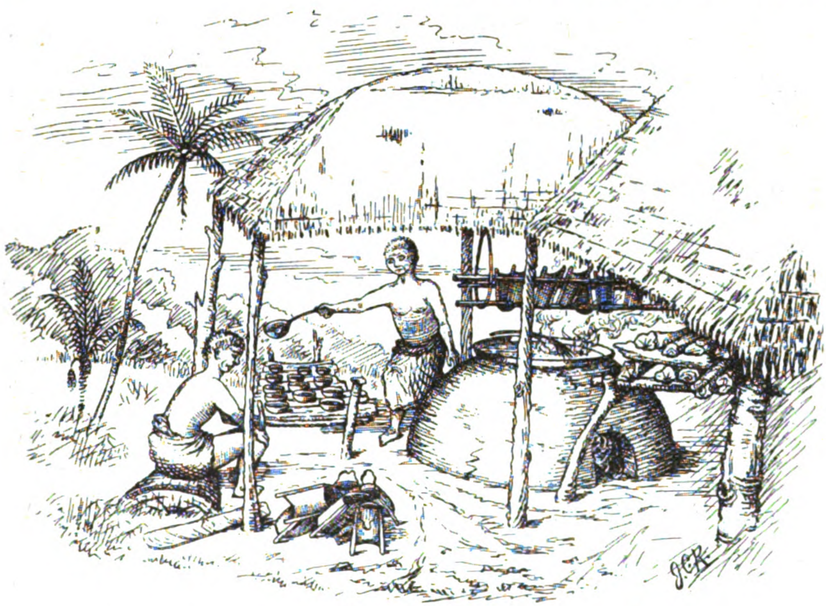


SAGUEIRO BUCKETS: MODE OF WEDGING SIDES OF BUCKET INTO BAMBOO; WOODEN PESTLE FOR BEATING FLOWER-STALKS.

pieces of bamboo, which each have a slot cut from the top to within a few inches of the bottom. Then a long wooden rod or wedge is driven down the interior of each bamboo, between the edges of the bucket-sides, as shown in the sketch. To keep the shape better, four or five rings of "gaba-gaba" or split leaf-rib of the sago-palm are often put at intervals in the interior of the bucket, and a handle of the same material completes the article, though the joints are usually caulked with "chunam," a mixture of lime and oil like putty. The inner polished and siliceous skin of the leaf-sheath forms the interior of the bucket, the exterior being left rough from the thinning-down process.

When the palm-sap is destined for sugar-making it is boiled in primitive fashion in some convenient clearing in the forest, in large, shallow iron pans set in the top of a dome-shaped clay or mud furnace. This is fired with chopped wood, a quantity of which is always piled on a rack near the furnace to dry. The empty sagueiro buckets, too, are generally suspended mouth downwards in a rack over the furnace, to clean and dry, for they cannot be left empty on the ground long without swarming with ants. A piece of the mid-rib of the sugar-palm leaf, beaten at one end to separate the fibres and make a sort of broom, is used to stir up the boiling liquor, and a rough iron ladle to test the syrup; whilst a primitive table of "gaba-gaba," and

stakes holding a supply of empty coco-nut shells in halves completes the sugar-maker's stock-in-trade. The whole apparatus is more or less protected from the weather by the usual attap-thatched open shed. The syrup is constantly stirred up with the broom to prevent burning, and from time to time a little is ladled out into a coco-nut shell to try its condition; as soon as a sample sets properly, the contents of the boiling-pan are ladled into the coco-nuts. The product forms dark-brown cakes resembling toffee in taste, and is either broken up and powdered to use like ordinary brown sugar, or melted down with a little water to make a syrup which is much eaten with sago; the broken pieces are also used as a sweetmeat.



SUGAR-BOILING.

This native manufacture of palm-sugar was still an important native industry in 1909, when Mr. F. Muir and the writer stayed some months in the Malay islands, but ordinary cane- and beet-sugar were displacing it by degrees, and doubtless before very long the making of palm-sugar by the natives will belong to past history. Yet this palm-sugar has a peculiar and nice flavour and, as the supply of firewood for boiling is free and at present unlimited, it is manufactured by the Malays at a very trifling cost.

The coarse black bast or fibre which covers the bases of the leaf-sheaths of the sugar-palm is made into cordage for rigging praus and other uses, and is known as *gamutu*. A peculiarly soft, dark snuff-brown material is scraped off the exterior of the trunk and employed both for caulking boats as already mentioned, and also for tinder. Nearly all the natives in Ceram carry a little tinder-box full of this stuff.

Wallace was, we believe, the first to notice at any length and at first-hand the manufacture of palm-wine and sugar from *Arenga saccharifera* in his "Malay Archipelago." Since he lived so many years in the fifties and sixties of the last century in these islands, they have certainly changed much. The area of actual forest on most of the islands has been greatly reduced, not so much formerly by the operations of Europeans as by the natives' habit of clearing patches of forest to enable them to grow a few bananas and vegetables and, after one crop was gathered, forsaking this ground and clearing another plot, to save the labour of properly tilling the soil. But of recent years Europeans have felled and burned off much valuable timber to make room for rubber and coco-nut and other plantations; much land in some parts has been disafforested and then deserted, and is now covered with low second-growth jungle, or, worse still, with the tall and harsh "Kusu-Kusu" grass, which is difficult to force one's way through, and cuts like knives. Ceram is at the present time almost the only island in the Dutch Indies which is practically untouched, and already forest is here being cleared for growing coco-nuts for copra. J. C. K.

HOME INDUSTRIES.

Bank Amalgamations.—Whilst banking business grows, and the aggregate of bank offices increases, the number of independent and private banks continues to diminish. The latest amalgamation is that of Messrs. Hill and Sons with Lloyd's Bank. The bank of Charles Hill and Sons was started by Mr. Charles Hill, who had been manager to Messrs. Sharpe and Sons, of West Smithfield. They failed in 1825, after which he immediately started as a banker, and carried the business on in his sole

name for three or four years, when he was joined by his sons, George Hill and John Hill. Charles Hill died in 1846, and George and John Hill carried on the business until April, 1867, when John Hill died, and John Hill junior was taken into partnership with his uncle. It is understood that all the partners will continue to be associated with the business, and the entire staff will be retained in the service of Lloyd's Bank, which will secure a valuable Smithfield connection by the amalgamation. Messrs. Hill and Sons have branches in West Smithfield, Islington, Deptford, Liverpool, Birkenhead and Romford. The number of branches of Lloyd's Bank is now raised to 601, which, in respect of the number of its offices, makes it the largest bank in the Kingdom, with the exception of the London, City and Midland, which has 680 offices. During 1910 the increase in the number of branch banks opened in England and Wales, compared with 1909, was 176, and in the United Kingdom 196. The growth of banking business in recent years is indicated by the growth of these bank offices, which in 1892 numbered less than 3,000; in 1886, 4,460; at the end of 1910, 8,279, including 123 belonging to foreign and colonial banks having offices in London.

Fire Insurance and Large Cities.—A recent discussion in the House of Commons arising out of a Bill promoted by the Newcastle Corporation disclosed very imperfect knowledge on the part of some of the speakers of fire insurance. The discussion occurred on a clause in the Bill to the effect that insurance companies having policies on property in the city shall contribute annually to the expenses of the fire brigade in proportion to the amount covered by their policies. The argument rests on the assumption that the insurance companies rather than the public benefit by the efficiency of the fire brigade, but that view can only be accepted with great reserve. Insurance companies charge what they consider adequate rates for each class of risk, and if heavy losses occur in any class or locality the rates for those risks are increased accordingly. If, on the other hand, losses are slight, competition sooner or later brings about a reduction of rates. It need hardly be added that the great insurance companies have contributed for many years past in London, Manchester, Liverpool, and other large towns.

The New Sub-Inspectors for Mines.—This new class of Sub-Inspectors of Mines is to number thirty, and the appointments will be made by the Home Secretary after a competitive examination limited to candidates nominated by him. Fifteen of the thirty are to be nominated as soon as possible, and fifteen later in the year. Of the thirty, twenty-two are to be appointed for the inspection of coal-mines and eight for the inspection of quarries. A certain number will be allotted to each of the six divisions into which the United Kingdom will ultimately be divided for the purposes of inspection, and will be selected from men working in the division. A separate examination will be held for the appointments in each division. The six divisions will be—(1) Scotland, (2) the Newcastle and Durham districts, (3) the Yorkshire division, (4) Manchester and Ireland and the Liverpool and North Wales districts, (5) the South Wales division, (6) the Midland and Southern division. The first fifteen appointments will be as follows:—Scotland, two for coal-mines; Newcastle, etc., two for coal-mines; Yorkshire, three for coal-mines; Manchester, etc., two for coal-mines, one for quarries; South Wales, two for coal-mines; Midland, etc., two for coal-mines, one for quarries. The salary of a sub-inspector is £150, rising to £200, and candidates must be between thirty and forty years of age, and have had practical experience in mines or quarries.

The Accountant Bill.—Accountants have long desired to place their profession in a position analagous to that of solicitor, doctor, and dentist, but it has been difficult to induce the chief organisations concerned to agree to a common plan. Now, however, a Bill has been drafted and read a first time in the House of Lords which is approved by the representatives of the Chartered and Incorporated Accountants. Registers are to be kept—one for England and Wales, one for Scotland, and one for Ireland—of all persons practising as professional accountants at the date of the passing of the Act. No unregistered person is to be allowed to use the title of professional accountant, or practise as such. The first persons to be registered if the Bill passes will be all existing members of the Institute of Chartered Accountants of England and Wales, the Society of Incorporated Accountants and Auditors, the three Scottish societies, and the Irish Institute, the members of certain colonial societies, and all other persons in practice as accountants in the United Kingdom at the date of the Act. After the passing of the Act no one would be registered unless he was a member of one of these bodies or had passed certain prescribed examinations. Fines and penalties would be imposed on any unregistered person who called himself a professional accountant, and there would be power to expel members, and all the machinery of the law to support the registrars and the committees. Members of the various existing bodies would still be able to call themselves "Chartered Accountants," "Incorporated Accountants," or otherwise.

Cotton Trade Statistics.—"The Cotton Spinners' and Manufacturers' Directory for 1911"—an invaluable compilation for all interested in the cotton trade—shows that the cotton industry, which has increased so largely of late years, has now become nearly stationary. During 1910 the increase in spindles was 270,606, which is the lowest since 1902, and in looms only 63, while there is actually a decrease of 11 in the number of firms, which is now 1,966. In 1904 there was a decrease in looms,

but the intervening years, up to 1910, have shown large increases, and in 1911 there has been practically no increase. The largest increase in spindles during 1911 is in the Manchester district, which on balance has added 353,090. Wigan has added 1,282 looms, Blackburn 978, Burnley only 146. Between 1905 and 1910 no less than 12,000,000 spindles and 90,000 looms were added to the industry. It is clear from these figures that the great period of expansion is at an end. It was time that it should be stopped, for the increase in productive capacity had gone ahead of the expansion of markets, large as that has been.

Small Holdings.—Parliament is about to be invited to discuss anew the comparative merits of the ownership or tenancy of small holdings. The Small Holdings Act has only been a qualified success. In 1895 there were 299,378 holdings of between one and fifty acres in England and Wales. In 1909 the number of small holdings had fallen to 288,011, and if certain necessary deductions are made, the approximate number of small holders is estimated by a well-informed writer in the *Times* at 250,000, of whom only 36,250 are proprietors. In 1909 the continuous decrease was stayed, but the net increase in 1910 was only 809. The smallness of these figures is largely owing to the absorption of many small holdings in urban districts, and to the fact that a large proportion of the new small holders were already tenants of some land. As to whether it is better to be owner or tenant, the experience of other countries—more especially France and Belgium—goes to show that the better policy is to assist small holders to purchase their holdings. Since the Small Holdings Act came into operation, only 2·3 per cent. of the applicants have expressed a wish to buy the land—the actual figures being 519 out of 22,455—but it does not follow that the applicants did not wish to buy it. They did not make application because they lacked the necessary capital for purchase and stocking. The Act does not facilitate purchase. It vests ownership in some department of the State or local authority. What may be done to help the small owner without injuring the seller is shown upon a farm in Bedfordshire—and a hundred other illustrations might be given—where a holding of some 400 acres was recently bought for its capital value at twenty-five years' purchase, and divided into eighteen small ownerships, ranging in size from 1 to 10, 20 and 40 acres. The occupiers pay annual instalments, ranging from 37*s.* to 43*s.* per acre, which also cover certain common rights. At the end of thirty-five years they will become absolute owners. But the shortest time under which a small owner can purchase under the Small Holdings Act is fifty years, and near by the farm to which reference is made above there is another bought by the county council and let to fifteen occupiers, who are paying within 3*s.* per acre in perpetuity of the price at which the holdings on the other farm were sold to occupying owners.

CORRESPONDENCE.

WHEELS, ANCIENT AND MODERN, AND THEIR MANUFACTURE.

My attention has been called to my reference to the Reid-Riekie wheel (*Journal*, April 7th, 1911, p. 532). To prevent a possible misunderstanding, may I add that the wheel there referred to is designed for steam lorries? I am informed by Mr. Riekie that the weight of springs for a motor-car wheel of this make is much less than I stated, viz., from 8 to 16 lbs., and that the free radial movement of the springs is in some cases as much as half an inch.

HENRY L. HEATHCOTE.

April 19th, 1911.

GENERAL NOTE.

SALMON-FISHING IN SIBERIA.—The most important industry of Nicolaevsk is fishing. About twelve years ago the business was of little importance, and its marvellous growth dates from that time. In 1909 the catch in the Amur River, and in the vicinity of Sakhalin Island, amounted to 90 million pounds, an increase of 18 million pounds over 1908. There are three varieties of salmon at these fisheries, namely, Gorbusha, summer, and autumn, the most valuable being the last named. Up to 1907 salmon caviar was considered valueless and was thrown away, but it has since come into use. It sells for three-halfpence in the district where obtained. The amount of caviar obtained from 1,000 Gorbusha salmon is 90 pounds, from the same number of summer salmon 126 pounds, and from 1,000 autumn salmon 144 pounds. About two-thirds of the annual catch of salmon is sold to Japanese fishermen from Hokodate, who prepare and ship them to Japan. The remainder is either smoked or salted, and packed in barrels for shipment to western Siberia and European Russia. There are two refrigerating plants near Nicolaevsk, and large quantities of fish have been frozen and shipped to Hamburg, but the enterprise has not been a success owing to lack of capital. In 1909, however, a British firm sent a refrigerating ship and took frozen fish to Europe, and it is understood that the enterprise was successful. Fishing in the Amur Province is almost entirely in the hands of the Cossacks, who own the lands along the river fronts.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

APRIL 26.—NOEL HEATON, B.Sc., F.C.S., "The Production and Identification of Imitation and Artificial Gems." Principal HENRY A. MIERS, M.A., D.Sc., F.R.S., will preside.

MAY 3.—A. W. GATTIE, "London Transport." JAMES SWINBURNE, M.Inst.C.E., F.R.S., will preside.

MAY 10.—HAL WILLIAMS, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

MAY 17.—Professor RAOUL PICTET, "Les Basses Températures."

MAY 24.—FRANK M. ANDREWS, "Architecture in America." Sir ASTON WEBB, C.B., R.A., F.R.I.B.A., will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

APRIL 27.—SIR THOMAS HENRY HOLLAND, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India." Sir ARUNDEL T. ARUNDEL, K.C.S.I., will preside.

MAY 25.—W. R. H. MERK, I.C.S., C.S.I., LL.D., "The N.W.F. Province of India."

COLONIAL SECTION.

Tuesday afternoon, at 4.30 o'clock:—

MAY 9.—F. WILLIAMS TAYLOR, "Canada and Canadian Banking."

CANTOR LECTURES.

Monday Evenings, at 8 o'clock:—

ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

May 1, 8, 15, 22.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 24...Victoria Institute, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Sir David Gill, "The Sidereal Universe."

Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. 1. Mr. Haydn T. Harrison, "The Ratio of Light to Illumination." 2. Mr. P. J. Waldram, "Some Notes on the Effect of Wall-papers upon the Illumination of Interiors."

Sanitary Engineers, 120, Victoria-street, S.W., 8 p.m. Mr. G. W. Chilvers, (a) "The Mechanics of Municipal and Sanitary Engineering"; (b) "Refuse Destructors and Power Plant."

Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on Mr. W. R. Baldwin-Wiseman's paper, "The Conservation of our National Water Resources," and on Mr. W. Vaux Graham's and Mr. H. F. Bidder's paper, "Judicial and Parliamentary Decisions with Regard to Rights in Underground Water since 1907."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Professor Beresford Pite, "Alberti and Bramante: Architecture a Profession or an Art in the Cinque Cento?"

TUESDAY, APRIL 25...Statistical, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. E. C. Snow, "The Application of the Method of Multiple Correlation to the Estimation of Post-Censal Populations."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. J. E. C. Bodley, "Cardinal Manning."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Annual General Meeting.

Zoological, Regent's-park, N.W., 8.30 p.m. 1. Mr. D. Seth-Smith, (a) "Penguins in Moult"; (b) "Wild Swainson's Lorikeets." 2. Dr. R. T. Leiper, "Some new Parasitic Nematodes from Tropical Africa." 3. Dr. Cuthbert Christy, "On a Collection of Antelope and other Skins from the Chagwe Forests, Uganda." 4. Dr. William Nicoll, "On Three new Trematodes from Reptiles."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mr. C. Bright, "Imperial Telegraphs."

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Dr. W. Rosenhain, "Steel." (Lecture II.)

WEDNESDAY, APRIL 26...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Noel Heaton, "The Production and Identification of Imitation and Artificial Gems."

Geological, Burlington House, W., 8 p.m. 1. Mr. Arthur Wade, "The Llandovery and Associated Rocks of North-Eastern Montgomeryshire." 2. Dr. J. D. Falconer, "The Geology of Northern Nigeria."

Chartered Institute of Secretaries, Great Hall, River Plate House, Finsbury-circus, E.C., 5.30 p.m. Mr. A. J. M. Brice, "The Law as to Misrepresentation."

United Service Institution, Whitehall, S.W., 3 p.m. Mr. P. Bramley, "The Indian Waterway from a Strategical Point of View."

Royal Society of Literature, 20, Hanover-square, W., 5 p.m. 1. Mr. F. R. Harris, "Lady Betty Molyneux." 2. Dr. W. E. A. Axon, "A Fourteenth Century French Fragment of Sydrach."

Mining and Metallurgy, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 8 p.m.

THURSDAY, APRIL 27...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Sir Thomas Henry Holland, "The Trend of Mineral Development in India."

Royal Institution, Albemarle-street, W., 3 p.m. (Tyndall Lecture.) Professor R. W. Wood, "The Optical Properties of Metallic Vapours." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Dr. Francis Ward, "Phases of Fish Life, and How to Record Them."

Optical, at the Chemical Society's Rooms, Burlington House, W., 8 p.m. Mr. H. S. Ryland, "The Forms and Errors of Visual Lenses."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Mr. A. M. Taylor, "Battery Economics and Battery Discharge Arrangements."

Historical, 7, South-square, Gray's Inn, W.C., 5 p.m. Dr. J. H. Wylie, "Notes on the Agincourt Roll."

FRIDAY, APRIL 28...Royal Institution, Albemarle-street, W., 9 p.m. Professor W. M. Flinders Petrie, "The Revolutions of Civilisation."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. T. Frame Thomson, "The Commercial and Technical Relations of Engineering Design and Work."

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7.30 p.m.

Zoological, Regent's-park, N.W., 4 p.m. Annual Meeting.

Physical, Imperial College of Science, South Kensington, S.W., 5 p.m. 1. Professor Ernest Wilson, "High-Tension Electrostatic Wattmeters." 2. Professor Ernest Wilson and Mr. L. C. Budd, "Previous Magnetic History as Affected by Temperature." 3. Dr. R. S. Willows and Mr. T. Picton, "Note on the Behaviour of Incandescent Lime Cathodes." 4. Dr. S. Marsh and Mr. W. H. Nottage, "On the Formation of Dust Striations by an Electric Spark."

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. 1. Mr. J. Emerson Dowson, "Gas-Producers." 2. Mr. E. A. Allcut, "The Effect of Varying Proportions of Air and Steam on a Gas-Producer."

SATURDAY, APRIL 29...Royal Institution, Albemarle-street, W., 3 p.m. Professor Selwyn Image, "John Ruskin: or, The Seer and Art."

Journal of the Royal Society of Arts.

No. 3,049. VOL. LIX.

FRIDAY, APRIL 28, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MAY 1ST, 8 p.m. (Cantor Lecture.) ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." (Lecture I.)

WEDNESDAY, MAY 3RD, 8 p.m. (Ordinary Meeting.) A. W. GATTIE, "Improvements in the Transport and Distribution of Goods in London." JAMES SWINBURNE, M.Inst.C.E., F.R.S., will preside.

INDIAN SECTION.

THURSDAY AFTERNOON, APRIL 27TH, Sir ARUNDEL T. ARUNDEL, K.C.S.I., in the chair. A paper on "The Trend of Mineral Development in India" was read by Professor Sir THOMAS HENRY HOLLAND, K.C.I.E., D.Sc., F.R.S.

The paper and discussion will be published in a subsequent number of the *Journal.*

CONVERSAZIONE.

The Society's Conversazione will be held, by permission of the Trustees of the British Museum, in the Galleries of the Natural History Museum, South Kensington, on Tuesday Evening, May 30th, from 9 p.m. to 12.

The Reception, by Sir JOHN CAMERON LAMB, C.B., C.M.G., Chairman, and the other Members of the Council, will be held in the Central Hall from 9 to 10 p.m.

A Selection of Music will be performed by the Band of H.M. Royal Artillery, in the Central Hall, commencing at 9 o'clock.

A Vocal and Instrumental Concert will be given in the Fish Gallery and a Miscellaneous Entertainment in the Shell Gallery, under the direction of Mr. PATRICK KIRWAN, commencing at 9.30 p.m.

The following portions of the Museum will be open:—

The Central Hall, containing cases of specimens illustrating Mimicry; Adaptation of Colour to surrounding conditions; Protective Resemblance; etc. Also specimens illustrating the Food of Fishes, and the Life History of the Eel (East of staircase).

The North Hall, containing the collection of Domesticated Animals.

The Bird Gallery, containing groups of British Birds and Nests; and in the Pavilion, at the West end, an exhibition of the Land and Fresh-water Vertebrate Animals of the British Isles.

The Fish Gallery, containing the Great Basking Shark, the grotesque Deep-sea Fishes (case 44), the Tunny (case 38), the Tarpon and Angler-fish (case 27), and the Lemon-Sole (case 30), etc.

The Shell Gallery, including a life-size model of a Giant Squid (Newfoundland), and of a Giant Octopus (California).

The East and West Corridors on the First Floor, containing the Okapi, African Antelopes, and Giraffes.

Light Refreshments will be supplied at Buffets in the North and South Corridors on the First Floor of the Museum.

Each member is entitled to a card for himself (which will not be transferable) and a card for a lady. (These cards will be issued shortly.) In addition to this, a limited number of Tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5*s.* each, if purchased before the day of the Conversazione. On that day the price will be raised to 7*s.* 6*d.*

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary at the Offices of the

Society, John-street, Adelphi, W.C. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

The Council reserve the right of stopping the sale of tickets or of raising the price, if it is found necessary, in order to restrict the number of visitors within reasonable limits.

Further particulars as to the musical and other arrangements will be given in the Programmes, which will be distributed on the evening.

PROCEEDINGS OF THE SOCIETY.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 26th, 1911; Principal Henry A. Miers, M.A., D.Sc., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Boyd, Miss Emma S., 18, King's-road, Southsea, Hants.

Croll, George, Camden House, Chislehurst, Kent.

Holland, William W., Ph.D., Johns Hopkins University, Baltimore, Maryland, U.S.A.

Holman, Arthur, Ishapore, Bengal, India.

Howat, William Frederick, M.D., Hammond, Indiana, U.S.A.

Sanguinetti, Vivian, c/o Dr. H. H. Sanguinetti, 19, Camden House-road, Kensington, W.

Triggs, Bernard, c/o Messrs. Cox & Co., 16, Charing-Cross, S.W., and Royal Bombay Yacht Club, Bombay, India.

Wood, Casey A., D.C.L., M.D., Suite 1208, Chicago Savings Bank Building, State and Madison-streets, Chicago, Illinois, U.S.A.

The following candidates were balloted for and duly elected members of the Society:—

Browell, Colonel Edward Thomas (late R.A.), Merrow House, near Guildford, Surrey.

Cotman, Henry William, The Quadrant, St. Ives Hunts, and the Arts Club, 40, Dover-street, W.

Evans, J. Howell, M.A., M.B., M.Ch. (Oxon.), F.R.C.S., 25, Berkeley-square, W.

Graham, W. L., 33, Bowerdean-street, Fulham, S.W., and Bon Accord Sheet Metal Works, Townmead-road, Fulham, S.W.

Hudson, Lieut.-Colonel Sir William Brereton, K.C.I.E., Fairholme, West Kensington, W.

Khan, Khur Shaid Ali, c/o Messrs. Henry Adams and Son, 60, Queen Victoria-street, E.C.

Provis, Charles Herbert, Highfield, Mutley-road, Plymouth.

The paper read was—

THE PRODUCTION AND IDENTIFICATION OF ARTIFICIAL GEMS.

By Noel Heaton, B.Sc., F.C.S.

In order to make the object and scope of this paper clear, I may say at once that I have not anything original to bring before you, or anything that is particularly new to those who have followed recent work on the artificial production of precious minerals. My object is more to review the whole subject in a comprehensive manner from its scientific and economic aspect, and particularly to bring the records of this Society up to date, as it were, by describing such advances as have been made since the subject of precious stones was last discussed in this room.

During recent years the production of artificial gems on a commercial scale has become an accomplished fact, and a great many misconceptions and misleading statements have been made as to the relation which these productions bear to natural products on the one hand and imitation gems on the other. It may therefore be of some use to make the matter clear by describing as fully as circumstances permit what has been done in this direction and what has not been done; what is practicable and what is impracticable in the present state of our knowledge.

I suppose there are few subjects of interest from so many points of view as that of precious stones. The beauty and rarity of fine specimens has from time immemorial rendered them the most treasured of possessions. With the romance that surrounds this aspect of the question we have nothing whatever to do to-night, except to bear in mind that on account of their great value men have for centuries strained their ingenuity to solve the mystery that surrounds the origin of such stones, and amass wealth by producing them at will instead of by the laborious and highly speculative process of digging for them in the earth.

Until the development of modern science and accurate methods of investigation, this problem

resisted all attempts at solution, and it is, in fact, only within the last few years that the artificial production of any species of gem on a commercial scale has become practicable.

Of course, one can cut the Gordian knot by preparing a colourable imitation of the real thing, but that is quite another matter, and I want to make it quite clear, at this point, that I propose to limit the term "artificial" to such productions as possess the same chemical composition and physical constants as the natural stones, differing from them only in minute details consequent upon their being produced in the laboratory instead of being dug out of the earth; all other makeshifts being properly described as "imitations." The production of *imitation* gems is by no means a modern invention, as is doubtless well known to you. To go no further back than the time of the Roman Empire, the master glassmakers of the dawn of our era, whose skill and knowledge of glassmaking one appreciates more highly the more one investigates the industrial life of those times, were able to imitate almost any precious stone exactly, as far as outward appearance went, in coloured glass—and not only the transparent gems, but the structure of such semi-precious stones as agate, cornelian, lapis, and porphyry. It would be quite out of place to devote any time to-night to this historical aspect of imitation gems, but I cannot refrain from alluding to the remarkable examples of such imitations found by Mr. Woolley at Karanòg,* from which it is difficult to resist the conclusion that in quite early times Nubia was the centre of this industry. To judge by the stories one reads about jewels in those times—stories of the Emperor Comnenus, for example—one suspects that the glassmakers turned their skill in this direction to some account and considerable profit on behalf of an ignorant and somewhat credulous aristocracy; for in those days, and, in fact, until quite recently, not only was the nomenclature of gems very vague, but methods of identification were chiefly remarkable for their non-existence.

The chief criterion of a precious stone was its colour, so much so that throughout mediaeval times blue glass was known as sapphire and green glass as beryl, etc., giving rise to the legend that in the time of Queen Elizabeth windows were glazed with sheets of beryl.* As the tendency still lingers to regard all red stones as rubies and green as emeralds, and so on, I would like to make it clear at this point that colour is really quite an accidental property of precious stones: the substance of which nearly every species of transparent gem is essentially composed is colourless, and the colour is really produced by minute proportions of impurity.

This being the case, we find that on the one hand the same species of gem may exist in a large variety of colours, and on the other hand that a colour characteristically associated with one gem may often be found in another having essentially different composition and properties. Owing to this confusion it was very difficult to draw the line between a genuine and imitation stone until the various species of gem stone were accurately defined and their names clearly associated with particular composition and properties, the

TABLE I.

PROPERTIES INFLUENCING THE VALUE OF PRECIOUS STONES AND USED AS MEANS OF IDENTIFICATION.

BEAUTY	Colour.		
	Structure	Cleavage.	
		Lamination.	
		Inclusions.	
	Optical Properties	Refractive Power [Refractometer].	
		Double Refraction [Polariscope].	
		Pleochroism [Dichroscope].	
		Dispersion.	
		Absorption Spectrum [Spectroscope].	
DURABILITY	Hardness [Hardness Points].		
	Toughness.		
	Chemical Composition.		
ADDITIONAL MEANS OF IDENTIFICATION	Specific Gravity.		
	Thermal Conductivity.		
	X-Rays.		

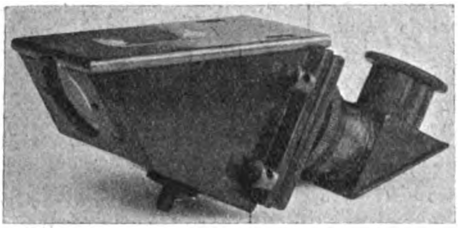
* "Karanòg," by C. L. Woolley and D. Randall. MacIver: Philadelphia Museum, 1910.

* This is quoted in Hollingshed. We read in Theophilus (II., Cap. xii.) of "tabulas saphiri pretiosas ac satis utiles in fenestris." In a previous paper (*Journal*, March 15th, 1907) I have shown how the name jet was applied indifferently to

determination of which forms, at the present time, a means of distinguishing one from another, and also of deciding whether an alleged gem is genuine or imitation with ease and certainty.

The scientific examination and identification of gems in this manner is a matter of the greatest

FIG. 1.



THE HERBERT SMITH REFRACTOMETER.

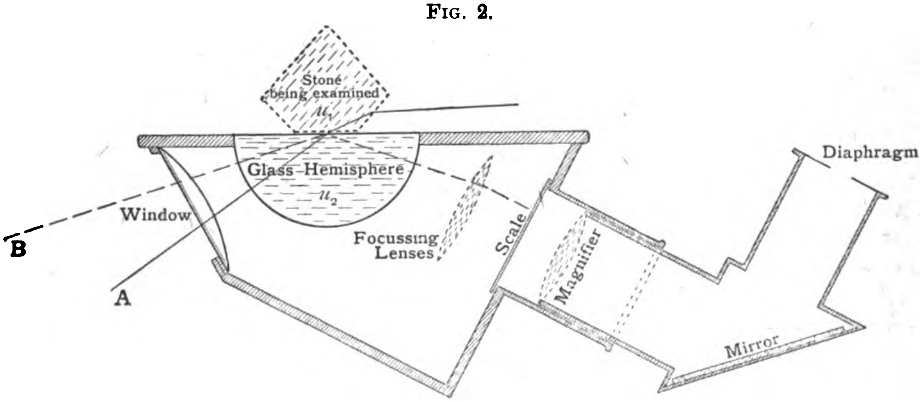
interest, but it would take far too much time to discuss it in detail, and it is quite unnecessary to do so, because it has already been brought before the Society most exhaustively by our chairman, Dr. Miers.* I propose, therefore, merely to remind you of the main points by means of the accompanying summary (Table I.).

In order to bring this matter up to date in the records of the Society, however, I must refer briefly to one or two particulars in which advance has been made since the time of these lectures.

The most important properties of a precious stone are those depending upon its refractive powers. Until recently the accurate determination of the refractive index of a stone was a matter involving the use of complicated and expensive instruments, and a matter for the skilled mineralogist rather than the practical jeweller. It is true that at the time Dr. Miers published his lectures there existed an instrument known as the Reflectometer, but the determination of the refractive index with this was a matter of some difficulty even in skilled hands, and its value for commercial purposes was very small. Since that time, however, thanks to the ingenuity of Dr. Herbert Smith, this instrument has been improved out of all recognition, and in its place we have the Herbert Smith Refractometer (Fig. 1), by means of which anyone of normal common-sense can determine the refractive index of a stone in a few seconds without even removing it from its setting, and which, with a little practice, will also enable one to determine with similar ease the amount and kind of double refraction and the degree of dispersion.

As will be seen from the diagram (Fig. 2), the main principle of the instrument is the same as that of the reflectometer, the refractive index being measured against a standard of highly refracting glass by means of the angle of total reflection, which of course diminishes, the nearer the index of the stone approaches that of the standard. It is, however, in the details of construction that such a marked advance has been made, and it is these details which make all the difference in practical work. To use this instrument all that has to be done is to place the stone under examination in optical contact with the flat surface of the dense glass, and arrange it so that a good light (preferably monochromatic) enters the instrument through the lower lenticular opening, when the refractive index is read off directly on a scale, without calculation.*

FIG. 2.



CONSTRUCTION OF THE HERBERT SMITH REFRACTOMETER.

Some little advance has also been made in the construction of the Dichroscope for determining pleochroism. As will be seen from the

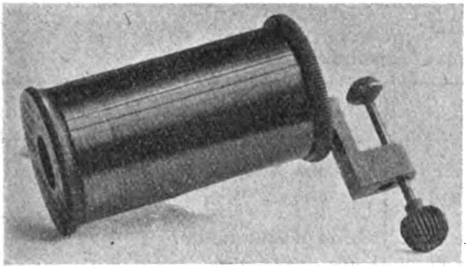
* Cantor Lectures on Precious Stones, April, 1896.

* It is impossible here to give any detailed account of the construction and use of this instrument. Full particulars will be found in "The Herbert Smith Refractometer," published by J. H. Steward, 406, Strand.

illustration (Fig. 3), the instrument in use to-day is provided with a revolving holder tipped with wax, to which the stone is readily fixed, leaving both hands free. A detail, but again it is such details that count in practice.

Taking the properties of precious stones as a whole, the great point about them is the remarkable combination of qualities; it is not so much that they have optical properties which make them extraordinarily beautiful, or that they have remarkable hardness and durability, but they have *both*, and it is the impossibility of reproducing this combination in any other material that renders the detection of imitations a matter of ease in the hands of anyone familiar with the facts.

Fig. 3.



The Dichroscope.

Of course, glass is the obvious material to use in the production of imitation gems, and, as I have indicated, it has been so used from time immemorial. And, in later times, while science was equipping the expert in precious stones with the means of identifying them with certainty, the maker of imitations was also invoking its aid in the production of more successful imitations.

In modern times the manufacture of imitation gems on scientific lines was introduced by Strasser in Vienna; hence the name "strass," although "paste" is the more commonly used term.

The finest of such modern paste bears little relation to the clumsy imitations of early times; the glass is specially prepared in order to combine, as far as possible, the necessary optical qualities with a fair amount of durability. It is well known that by using lead instead of lime as the basic constituent, the refractive index and dispersive power of glass are much increased, and by replacing the alkaline constituent by thallium oxide in the same manner the refractive index may be raised as high as 1·96 and the dispersion to 0·049.* By adjusting the composition in this way, and preparing the glass with the greatest regard to the purity of the materials, manipulating it, moreover, in a similar elaborate manner to that employed in the production of glass for optical instruments, in order to secure the utmost freedom from striation and inclusions, it is possible to imitate any precious stone accurately, as far as outward appearance is concerned.

The trouble is, however, that with glass the more you increase its refractive power in this way the softer and less durable it becomes, until you find that the very "dense" flint used for the refractometer, having a refractive index of 1·8049, is so soft that it has to be handled with great care to avoid scratches, and so little resistant to decay that in a comparatively short time the exposed

TABLE II.

Identification of Imitation Gems.

Paste.	Stones.
Index of Refraction rarely exceeds 1·65.	Index of Refraction ranging up to 2·4.
Single Refracting, or false double Refracting owing to strain.	Double Refracting, with exception of Diamond, Garnet, and Spinel.
Never Pleochroic.	Often strongly Pleochroic when coloured.
Hardness always below 7.	Hardness 7 or over (with a few exceptions).
Specific Gravity usually above 4.	Specific Gravity usually below 4.
Thermal Conductivity low.	Thermal Conductivity comparatively high.
Opaque to X-Rays.	Translucent or transparent to X-Rays.
Generally show spherical bubbles and curved striae.	Frequently show lamination or inclusions.

* These are the constants given for the Jena glass, No. S. 57: the specific gravity is 6·33. Refractive index of diamond is 2·4, and dispersion 0·057.

surface becomes corroded, which is the one weak point of this instrument. It is true that this softness may be counteracted to some extent by further adjustment of the composition, adding a proportion of alumina and zinc, and by careful thermal treatment of the finished stone in some such manner as that originally introduced by Bastie, in which the glass is case-hardened by plunging whilst hot into a bath of oil. In some of the best modern paste I have found a refractive index of over 1·6 combined with a hardness close on that of quartz, but this is the absolute limit, and it is not possible in any way to obtain a paste that cannot be scratched with a hardened steel point. Paste can also be readily identified by means of the scientific tests, as indicated in Table II.

The most important point to remember about paste, however, is its lack of durability; it is not only too soft to stand much wear, but its composition is so unstable that it rapidly deteriorates and loses its brilliancy on exposure. You will see, therefore, that although there is a certain legitimate scope for such paste imitations they are very unsatisfactory substitutes for the genuine article. This being the case, as scientific knowledge has advanced, attention has been more and more concentrated on the problem of producing by artificial means the actual minerals found in nature, and thus obtaining what I have defined as artificial in contradistinction to imitation jewels, having both the beauty and durability of the natural article without the objectional concomitant of enormous cost.

TABLE III.

COMPOSITION OF THE PRINCIPAL PRECIOUS STONES.

	SPECIES.	VARIETY.	COMPOSITION.
ELEMENT	Diamond	—	Carbon.
OXIDES	Corundum	Ruby. Sapphire Oriental Amethyst, etc.	Oxide of Aluminium.
	Quartz	Crystal. Amethyst Cairngorm, etc.	Silica.
ALUMINATES	Spinel	Balas Ruby, etc.	Magnesium Aluminate.
	Chrysoberyl	Cymophane Alexandrite	Beryllium Aluminate.
SILICATES	Beryl	Emerald Aquamarine	Beryllium Aluminium Silicate.
	Garnet	Hessonite	Calcium Aluminium Silicate.
		Pyrope	Magnesium Aluminium Silicate.
		Almandine	Iron Aluminium Silicate.
		Demantoid, etc.	Calcium Iron Silicate.
	Olivene	(Peridot)	Magnesium Iron Silicate.
	Sphene	—	Calcium Titanium Silicate.
	Spodumene	(Kunzite)	Lithium Aluminium Silicate.
	Topaz	—	Aluminium Fluo-Silicate.
	Tourmaline	—	Complex Alkali-Lime-Alumina Silicate.
	Zircon	Jargoon Hyacinth	Zirconium Silicate.
	Turquoise	—	Hydrous Aluminium Phosphate.
	Opal	—	Hydrous Silica.
	Pearl	—	Calcium Carbonate.

The first point to be considered in attacking this problem is the composition of the stone, as it is obvious that, other things being equal, the possibilities of success are greater with one of simple than one of comparatively complicated composition. One also has to consider, however, the economic aspect—it is not much use devoting time and ingenuity to the production of an artificial stone when the natural one is so common that the cost of the two would be practically identical.

Taking these two points in conjunction, and

confining our attention for the moment to the transparent stones as summarised in Table III., the diamond appears to offer the most promising field for attack and corundum comes next, and we find that the main attempts at artificial production centre round these species. From the point of view of composition alone, quartz is the most simple, but it is so common in nature as to render its artificial production scarcely worth while. The aluminate group offers some attraction, but the artificial production of crystalline silicates on a large scale is a very difficult problem, and, with the exception of the emerald, the stones comprised in this group are so freely distributed in nature as to render their artificial production a matter of academic rather than industrial interest.

It is unnecessary to discuss at any length the artificial production of the diamond*—the problem has been attacked by numerous scientists, and was solved by Moissan some years ago. Some fifteen years ago, on the occasion of a visit to Paris, I had the privilege of witnessing the production of his diamonds, prepared, as all the world knows, by saturating iron with carbon at the temperature of the electric arc and plunging the molten mass into cold water. The mass of iron is then dissolved in acid and the residue subjected to a laborious process of extraction, the diamonds being picked out by aid of the microscope. The largest diamond that has been produced in this way is barely visible to the naked eye, however, and when I say that the problem of their production has been solved, I mean from the scientific point of view.

The artificial production of the diamond is, in fact, far more complicated than it appears at first sight. If it were only a matter of obtaining the necessary high temperature to fuse the carbon to obtain it in the crystalline condition it would be simple—such high temperatures are readily obtained nowadays by means of the electric furnace and the oxy-acetylene flame—but carbon is one of those substances which pass direct from the solid to the gaseous state under ordinary atmospheric conditions, and only assumes the liquid condition under enormous pressure. The combination of high temperature and enormous pressure can be obtained momentarily by Moissan's ingenious process, but to obtain crystals of any size it is necessary to conduct the operation on a very large scale and to maintain the combined temperature and pressure for a sufficient length of time to allow the liquid carbon to separate out from its matrix; moreover, the entire operation must be conducted out of contact with air, for carbon rapidly combines with oxygen at high temperatures.

Commercially, we are as far from being able to produce artificial diamonds as in the days of the alchemists. It is, perhaps, a bold thing to say that no such thing as an artificial diamond will ever be placed on the market, but one can safely assert that so far as our knowledge stands at present it is impracticable. In saying this, I am quite aware that statements as to the commercial production of synthetic diamonds being an accomplished fact have quite recently appeared broadcast in the public press, but those who are responsible for such statements are, shall we say, under a misapprehension as to the meaning generally conveyed by the term "synthetic," and are unable to follow the distinction I have drawn between an artificial gem and an imitation.

To pass on to corundum, the problem of its artificial production is very much simplified by the fact that its composition is oxide of aluminium, and alumina—which is, therefore, its amorphous equivalent—fuses to a liquid under ordinary atmospheric pressure at a temperature somewhere about 2,000° C. (the exact point has not as yet been determined), and being the only stable oxide of a strongly basic metal, it can be heated in air without any change.

The chief problem to be faced, therefore, is that of attaining the necessary temperature, and it is not surprising that crystalline alumina was produced as a scientific curiosity as far back as the commencement of the nineteenth century. It is at this time that we first begin to hear of the oxy-hydrogen blowpipe (or the gas blowpipe as it was then called), and in a book published in 1819,* describing various experiments with this new apparatus, we read that "two rubies were placed upon charcoal and exposed to the flame of the gas blowpipe . . . after suffering it to become cold . . . the two rubies were melted into one bead." This hint does not appear to have been followed up for some considerable time, however, and the earlier experimenters in the production of artificial gems worked in another direction; they were unable to obtain products of commercial utility, because although they succeeded in obtaining crystalline alumina, it was produced

* A complete account is given in "Diamonds," by Sir William Crookes (Harper's Library of Living Thought).

* "The Gas Blowpipe," by Dr. E. D. Clarke.

under conditions which resulted in the formation of a mass of small crystals, almost microscopic in size. Moreover, the form of these crystals was that of the hexagonal plate which is the fundamental form of corundum, and such a form would be useless for cutting even when of considerable area, owing to its thinness. Thus Gaudin, who appears to have been one of the first to attain any success in this direction, obtained a mass of such crystals by fusing alum and potassium sulphate in a closed crucible. Ebelman obtained similar results by fusing alumina with borax, and later Deville and Caron used aluminium fluoride and boric acid. All these attempts yielded similar results, as in each case fusion was obtained by the aid of a substance melting at a lower temperature which acted as a solvent. Consequently the alumina crystallised out in much the same manner as a salt crystallises from a saturated solution, and to obtain sufficiently large crystals to be of practical use it would be necessary to conduct the experiment on a very large scale, and subject the fused mass to very slow and carefully-regulated cooling.

In 1877 Fremy and Feil attempted to get over this difficulty by using lead oxide as the flux and employing a crucible composed of highly-acid clay. On heating up the mixture in such a crucible the lead oxide melts and combines with the alumina to form lead aluminate, and on further heating this reacts with the silica of the fire-clay, forming lead silicate and setting free the alumina, which crystallises out. But although very much larger crystals were obtained by this ingenious process they had the same form, and were too thin for industrial employment.*

Some time earlier than this, however, we hear of the oxy-hydrogen blowpipe again, for Gaudin had noticed (as Clarke did in 1819) that by introducing alumina into the flame of an oxy-hydrogen blowpipe he could obtain globules of fused alumina similar to the borax beads one makes in the ordinary blowpipe. Gaudin appears to have taken it for granted that these beads were amorphous—that is, an alumina glass—and it was not realised until many years later that they were really identical in all their properties with natural crystalline corundum. When this was realised, the commercial production of corundum became only a matter of detail.

Having obtained this further point, the idea immediately suggests itself of converting small and useless stones into valuable gems by fusing them together into one, and, as a matter of fact, "reconstructed rubies"—as stones produced by this method are now generally called—made in this manner were the first artificial gems to be prepared on a commercial scale. These were introduced some quarter of a century ago under the name of "Geneva rubies," and were offered as, and realised the price of, natural stones, until the method of their production became apparent.

It will, of course, be well understood that the experiments I have briefly indicated towards the artificial production of corundum had as their immediate objective the formation of ruby, that being by far the most valuable variety. It had long been known that the colour of the ruby was due to a trace of chromium, and by adding a small proportion of potassium or ammonium chromate to their mixture, Fremy and Feil reproduced accurately the colour of the ruby in their crystalline flakes.

The process of producing reconstructed rubies by means of the oxy-hydrogen blowpipe is, roughly, as follows:—The residue from cutting rubies and small worthless stones is broken into coarse sand, a small quantity of which is placed on the centre of a disc of platinum; this is then carefully brought to the fusion point, care being taken at this stage not to raise the temperature to such an extent as to melt the platinum support. As soon as this mass is fused it serves to protect the platinum, and the reconstructed ruby can be built up on it by adding the fragments of ruby one at a time by means of small platinum forceps. These pieces have to be dropped on with great care in order to secure incorporation with the mass and prevent as far as possible the formation of air bubbles. It will be readily understood that this process is a tedious and laborious one, and, in fact, the formation of masses of sufficient size to yield large stones on cutting is a matter of such difficulty that the cost of production is very high.

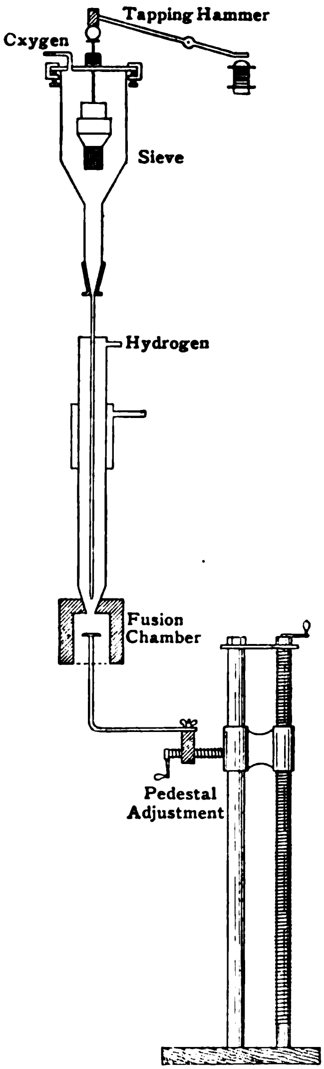
Just about seven years ago, however, Verneuil* overcame this restriction when he hit on the extremely ingenious idea of introducing the raw material through the blowpipe, and thus placing it on the support automatically. The diagram (Fig. 4) shows the principle of his apparatus. The blowpipe is arranged vertically over a small insulated chamber containing the

* For a full account of the history of these earlier attempts, see "La Synthèse du Rubis," by F. Fremy, 1891.

* "Mémoire sur la reproduction artificielle du rubis par fusion," M. A. Verneuil, *Annales de Chimie et de Physique*, Sept., 1904.

support on which the mass is to be built up. The oxygen tube communicates at its upper extremity with a funnel-shaped hopper, in which is suspended a small sieve filled with the raw material, which is rhythmically shaken by means of a small hammer actuated by an electro-magnet or cam. Each time the hammer taps the support of the sieve, causing it to

FIG. 4.

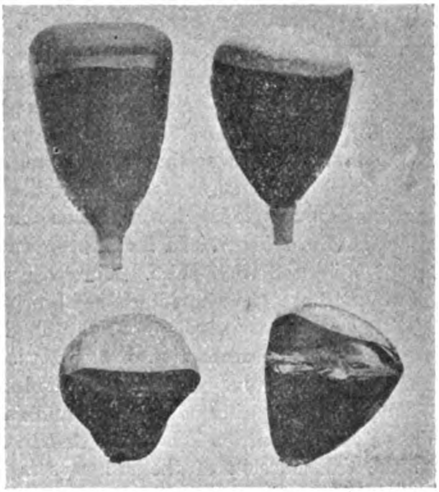


PRINCIPLE OF VERNEUIL'S APPARATUS FOR PRODUCTION OF ARTIFICIAL CORUNDUM.

vibrate, a small quantity of the powder falls through into the tube below, and, carried along by the gas, passes out at its lower extremity into the zone of flame, where it is immediately raised to the fusion point, and falls as a melted globule on to the support below.

As seen in the diagram, this support is arranged with a screw adjustment, so that as the mass of corundum is gradually built up by the constant addition of fresh globules the surface can be kept at a constant level, and the portion already formed removed from the zone of heating so as to allow it to stiffen. When the apparatus is first started the blowpipe is adjusted so as to give a comparatively cool flame, and the powder is admitted slowly. By this means a small "stalk" is formed, which insulates the mass from the support and prevents the fusion of the latter. When this has been formed the full pressure of the blowpipe is put on and the rate of admission increased, with the consequent formation of a "boule," as it is termed, having the shape of a pear as illustrated in Fig. 5.

FIG. 5.



"BOULES" OF ARTIFICIAL CORUNDUM.

With this apparatus a boule weighing some twenty to thirty carats, and capable of yielding two cut stones of about six carats each, can be prepared in about half an hour almost automatically, a single operator being able to control several machines. The boules, on cooling, very often split in half in the direction of their growth, as in the lower example seen in Fig. 5, and this is a convenience rather than otherwise, as the resulting shape can be cut to greater advantage.

In the first instance reconstructed rubies were made in this way after the manner introduced by Gaudin, the material fed into the blowpipe being pulverised rubies and chips, and this method is still employed by some workers. But more commonly nowadays the corundum is produced direct from amorphous alumina by using pure ammonium alum as the raw material. On reaching the flame this decomposes, the

ammonia and sulphuric acid volatilising, leaving the alumina. Stones made by this process are generally known as "synthetic," as distinct from "reconstructed," although, of course, to be pedantic, the process is one of decomposition rather than synthesis.

The "synthetic" corundum produced in this way, if pure ammonium alum is used, is, of course, colourless, and can be used as artificial white sapphire. If a small proportion of chrome alum is added, the resulting stones are rubies, and other colours may be produced in the same way. For a long time all attempts to reproduce the fine blue of the sapphire failed, because, following the apparent analogy of silicates, cobalt was invariably employed as the colouring agent. This, however, does not readily form an aluminate in the same way that it does a silicate, and, in consequence, it is impossible to produce a satisfactory colouration in the corundum by its means; it is possible to get the cobalt in a state of combination by adding a large proportion of magnesia to the alumina, but then the product formed is not a crystalline alumina but magnesium aluminate, and its properties are fundamentally different. Its refractive index is lower, its refraction single, and its hardness lower. In fact, the result is blue spinel instead of sapphire. Moreover, such blue stones have the characteristic absorption of cobalt, and appear purple in a light that does not contain a large proportion of blue rays.

In 1908 Paris attempted to avoid this latter difficulty by preparing a calcium aluminate coloured with cobalt, as it is found that in this case the transmission of the red rays is less pronounced. But the calcium aluminate so formed is not crystalline at all, but amorphous. A year or so ago, however, the problem of producing synthetic sapphire was finally solved by the use of titanium oxide, a very unexpected result, considering the chemical position of this element. With this last advance the artificial production of the corundum gem-stone may be considered to be completely solved, and cut stones can now be obtained in every variety of colour, from pure white to ruby and sapphire, at prices ranging from four to ten shillings a carat, according to colour, quality and size.

Whatever may be their economic importance, a very much debated question, there can be no doubt as to the scientific interest of this group of artificial gems. In the first place it is a matter of some interest that a mass of fused material formed in this way should not only be crystalline but possess all the characteristics of a single crystal. Crystallographers are agreed that each boule is a single crystalline individual, with the axis roughly perpendicular to the plane of formation—that is to say, running from the point of attachment of the pedestal to the top of the mass. On the top of the boule one invariably finds a mass of symmetrically-arranged facets, which Dr. Herbert Smith has found to correspond with the fundamental rhombohedron of corundum. Judging by analogy with other materials, one would expect at first sight that a fused mass formed in this way would be either a heterogeneous mass of minute crystals, or entirely amorphous, possessing the structure characteristic of glass. It is well known, for example, that under similar conditions pure silica yields "quartz glass," which is extensively manufactured at the present time. One is tempted to dwell upon this point, and discuss its bearing on such matters as the devitrification of glass, but it would be entirely out of place to do so in the present paper.

Then, again, there is the matter of colouration. One would like very much to know what is the state of combination of the chromium in a ruby, and whether the colour is produced by chromium aluminate in solution or metallic chromium in molecular suspension. In glass, as is now well established, this colour is produced by the optical effect of ultra-microscopic spheres of metallic gold or copper, but there seems to be no parallel between the two cases.

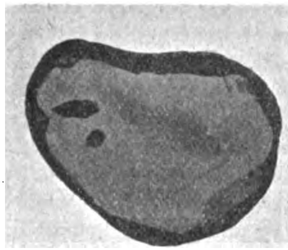
A point of more practical interest is the fact that although the artificial corundum is a true crystal it possesses the shape and formation of a congealed liquid or glass. The practical interest of this lies in the fact that it affords the only means of distinction between this artificial corundum and the naturally-formed gem-stone. Being of exactly the same composition and crystalline structure as the natural mineral, it cannot be identified by any of the physical tests I briefly referred to above. For all practical purposes the artificial ruby *is a ruby*, and one can only deny that it is a "genuine ruby" if this word is held to connote essentially a product found in the earth and not made by man.

And yet, owing to the curious anomaly of its structure, the artificial product can almost invariably be distinguished from the natural with the greatest ease. In the naturally-formed stone any foreign matter which may be present is coerced into following the lines of growth of the crystal, and more particularly bubbles of gas which may be present in the liquid are

distorted from their natural shape so as to accord with this symmetrical growth. It is the great exception to find a natural ruby entirely free from such inclusions, which generally form irregular cavities with a decided tendency to geometrical shape.

It is very common also to find the structure

FIG. 6.

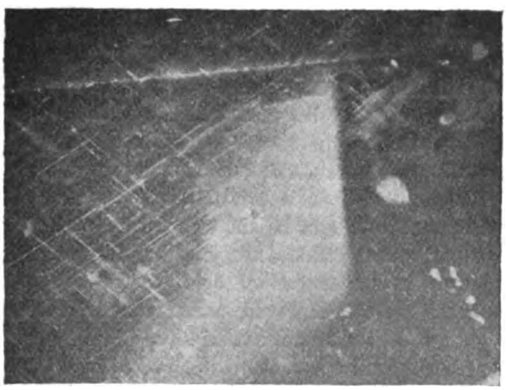


SECTION OF NATURAL RUBY, × 10.

technically known as "silk" caused by microscopic bubbles drawn out into a series of parallel canals, all lying in one plane. Any variation of colour in different portions of the stone also follows the lines of growth in this manner (Figs. 6 and 7).

In the artificially-produced corundum, on the other hand, although the particles arrange themselves symmetrically, any air bubbles that are entangled in the successive globules remain undisturbed, and appear as naturally spherical bubbles in the finished product; and, moreover, if one globule differs slightly from another in the proportion of chromium, the resulting

FIG. 7.

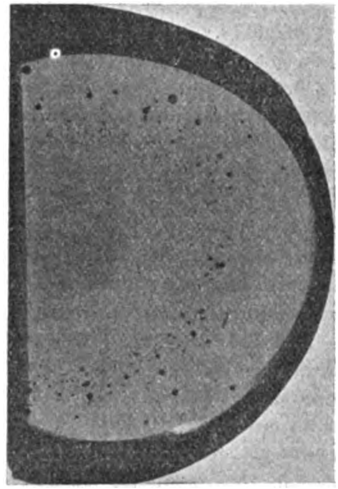


SECTION OF NATURAL RUBY, × 100.

difference in colour follows the form of the mass as a whole, the zones of colour being circular (Fig. 8).

As some of the air entangled between the fine particles fed into the blowpipe almost invariably fails to make its escape during the brief fusion, the presence and form of the bubbles is in this way sufficient to identify the artificial process of formation.

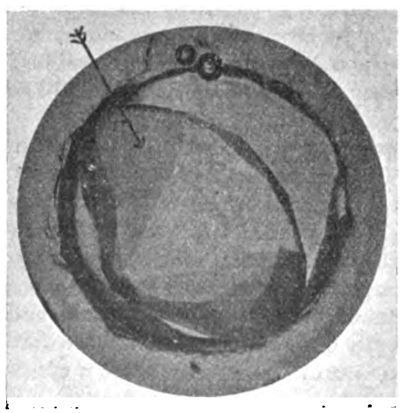
FIG. 8.



SECTION OF ARTIFICIAL RUBY, × 10.

In the great majority of cases examination of the cut stone with a lens is sufficient to decide the point, but in doubtful cases a more minute examination may be made by placing the stone in a little cell filled with highly-refracting liquid, in order to secure regular illumination, and examining it under the microscope by transmitted light, when the minutest trace of structure can be detected (Fig. 9). In

FIG. 9.



SMALL ARTIFICIAL SAPPHIRE, MOUNTED IN CELL, × 10, SHEWING MINUTE BUBBLES.

the case of an absolutely flawless stone it would be impossible to decide whether it were natural or artificial, but such stones are so rare that this case is almost theoretical.

It is claimed in some quarters, it is true, that "experts" can invariably distinguish the artificial product merely by reference to the colour, which is said never to be exactly the same as that of the natural stone, much as this latter varies. Personally, however, I am rather sceptical on this point, as one knows that experts claim in a similar manner to distinguish between one species of natural gem-stone and another by colour alone, and their results are not *always* in accordance with scientific tests. At any rate such dexterity can only be acquired by a lifetime of specialised experience.

As I have already indicated, spinels may be produced artificially by the same process as corundum, adding the necessary magnesia to the alumina, and the same remarks apply to the production and identification of this species as to corundum, the artificial stone being identical with the natural in all respects except those to which I have just referred.

As regards the remaining transparent gemstones, which fall into a group by reason of the fact that they contain silica as an essential component, their artificial production is of little importance. They cannot be produced by the same process as corundum, owing to the fact, already alluded to, that under such conditions both pure silica and compound silicates yield an amorphous product, which has not the optical properties of the natural stone. One is constrained, for the artificial production of the crystalline material, to fall back upon methods similar to those employed in the earlier attempts to obtain ruby—obtaining the requisite composition by chemical reaction and maintaining the mass at a temperature just above its fusion point for a sufficient time to allow the silicate to crystallise out.

Topaz, garnets, and zircon have been produced in this way experimentally as a matter of scientific interest, but the small stones produced have no commercial value, and to describe their production in detail would only weary you to no purpose. The majority of these stones are of such common occurrence in nature, and consequently of such little value, that their artificial production in this manner is not a commercial proposition.

An exception, however, must be made in the case of emerald, which ranks next in value to corundum, and many attempts have been made to produce it artificially. Reconstructed emeralds have been made by the Verneuil process, but these are, of course, amorphous, and do not possess the double refraction and other properties consequent upon the crystalline structure of the natural stone. The problem of producing this stone artificially has not as yet been solved in fact. I am quite aware in saying this that recent newspaper reports lead one to believe otherwise, but, as in the case of the diamond, such reports indicate either remarkable foresight on the part of the writers or show that their imagination is developed at the expense of their powers of accurate observation.

There remain now to be considered those precious stones which are opaque, and owe their beauty entirely to colour and structure.

Turquoise is a stone formed under conditions which are easy to reproduce, and its artificial production was successfully accomplished, many years ago, by precipitating hydrated phosphate of aluminium with the requisite proportion of copper phosphate to give it the colour, and subjecting the precipitate whilst still damp to hydraulic pressure for a considerable time. Prepared in this way the artificial turquoise is so nearly identical with the natural that its identification as a matter of considerable difficulty. There is, however, generally a slight difference in the specific gravity, hardness, and index of refraction (when this can be measured), which will serve to distinguish it on careful examination. The only point in which there is any decided difference between the two is the behaviour on heating, but as this involves the destruction of the stone it cannot be offered as a practical test.

Opal consists essentially of what is known as colloid silica, that is, silica in the amorphous state and combined with water. The play of colour one associates with it is entirely an optical effect, due to an accidental structure of the stone, which is permeated by a number of minute fissures, between which a thin film of air penetrates, the extreme thinness of this film causing the optical effect known as interference. If a piece of opal is powdered it is no longer coloured, as would be the case with a ruby or sapphire, but yields a dirty white powder, and generally a specimen of opal, as found, only shows the structure in parts, the remainder being dull and lustreless like flint.

This peculiar structure is, moreover, by no means confined to opal, but may occur in any mineral deposited under similar conditions. In the mineral known as Lumachello, or fire-marble, for example, the same effect is seen in a limestone. But opal is the only mineral which combines this structure with sufficient durability for use as a gem-stone, and in this connection

it should be remembered that, as a matter of fact, it only just possesses sufficient hardness for this purpose, and is one of the softest and least durable of all the precious stones. This fact, combined with the fragility consequent upon its structure, has involved the opal in a mass of superstition and romance from time immemorial.

Although it has this unfortunate drawback, opal is, at any rate in my estimation, the most beautiful of the precious stones, and when one appreciates the reason of its beauty it will be readily understood that its artificial production, or even successful imitation, presents almost insuperable difficulties.

It is true that a somewhat similar play of colour can be imparted to glass by rendering it translucent by a slight addition of arsenic or tin in the making, and by etching the surface in various ways, and such iridescent glasses are often found naturally as the result of decomposition, but this is merely a surface effect, and such specimens cannot be cut to advantage; moreover, they lack the beauty caused by the fire permeating the entire substance of the gem. The opal ranks with the diamond, therefore, in resisting attempts at artificial production, and is even superior to it in that it cannot be really successfully imitated.

I come finally to the pearl. This, of course, differs from all other precious stones in being entirely of organic origin. The peculiar lustre of the pearl, like the colour of the opal, is due rather to its structure than its composition. It is formed in the oyster by the deposition of successive layers of calcium carbonate round some central object, and consists of an innumerable number of thin overlapping laminæ of the crystalline variety of this substance known as aragonite. These layers being semi-transparent, the light falling on the surface is partially reflected from the surface and partially transmitted into the stone, where it suffers reflection from the surface of lower layers (Fig. 10).

To produce this complicated structure artificially is practically impossible, unless one can describe as an artificial pearl that formed by the oyster in response to the deliberate introduction of irritant foreign matter by human agency. But in this case, who shall decide where nature ends and human ingenuity begins? Perhaps the well-known Japanese pearl may be correctly described as artificial pearl, although the oyster has a great deal to do with it.

Such pearls are formed by introducing a mother-of-pearl shape between the shell and mantle of the oyster and then leaving the oyster alone for a time to allow it to convert this into a pearl by the deposition of several layers of nacre. The mass is then removed from the shell and converted into the semblance of a true pearl by supplying a back of mother-of-pearl. Such pearls, however, never have the fine orient of those produced under normal conditions, and they can readily be detected by examining the back, when the lustreless mother-of-pearl and the line of junction can be detected.

Of course, wonderful imitations of pearl are made in various ways, which are difficult to distinguish from the natural article by casual examination. One method of preparation is as follows:—Small hollow spheres are blown in opalescent glass, coated inside with a preparation of fish scales, and then filled up solid with wax. Such imitations are identified by examination of the hole or by putting a spot of ink on

FIG. 10.

SECTION OF PEARL, × 50.

the surface, when the reflection from the inner surface of the glass is seen. These empirical tests are usually sufficient, and it is rarely necessary to resort to testing the specific gravity and hardness, which provide further means of identification. It is worthy of note, however, that such imitation pearls are unique amongst imitation gems in that, in some respects, they are actually superior to the natural article. They are considerably harder for instance, and their lustre is not affected by constant wear.

In conclusion, I would like to refer very briefly to the present position of gems from the economic point of view. It is, perhaps, natural that the considerable influx of artificial gems in recent years, more particularly of the corundum species, has led to a great deal of controversy and difference of opinion as regards their merits. On the one hand the vendors of the artificial stones often publish extravagant

statements as to their defying identification, which, as I have shown you, is all nonsense. On the other hand, those interested in maintaining the prestige of the natural article make equally unreasonable statements, to the effect that such artificial productions, to quote a recently published circular, "are as worthless as the jewellery from a Christmas cracker." I have, I hope, clearly shown you the immense difference that exists between the imitation and the artificial ruby, taking an example; the former, it is true, depreciates rapidly in use, and deserves such a description, but the latter has absolutely all the essential qualities of the natural stone, and to place the two on the same plane as worthless trash is unfair to modern science and ingenuity. It must be clearly understood that there is no essential difference discernible between natural and artificial ruby as regards their beauty and their durability, which, as we have seen, are the two great items in the intrinsic value of a stone. But, of course, the price of a stone is chiefly determined by that third factor, which I have not so far taken into account—namely, rarity. Personally, I must confess that I have never been able to see why one should value a thing for no other reason than that it is difficult to get, although I suppose here I am in a hopeless minority, and that it is and always will be human nature to take this view.

It would serve no useful purpose to enter into that fruitful subject of controversy, the price of an article due to extrinsic causes, but I may say this—that whilst to me personally one is as good as the other, if any man is prepared to pay £100 for a natural stone when he can obtain essentially the same thing, artificially produced, for five, he is absolutely entitled to get it; and I would not wish you to think that I would defend for a moment the man who attempted to supply artificial as natural. But if this is so, it is still more the case that nobody has any right to supply anyone with paste under the name of artificial (or synthetic, or scientific, if these names are preferred) gem. I do think that the distinction between the two should be clearly recognised, and that it should not be permitted to use the term artificial indiscriminately. At present this is being widely practised; every day one sees offered for sale "rubies, emeralds, sapphires, and pearls artificially produced and having all the properties of the natural stone." Now, as I have indicated, such a thing as an artificial emerald answering this description is unknown, and, as a matter of fact, the stones supplied under this title are, as a rule, nothing more nor less than paste imitations, the public being deliberately led to believe otherwise. There is in this case, as I have indicated, a real practical difference between the two articles, not merely a question of opinion.

Again, one must deprecate the custom that has sprung up of arguing that, because "a rose by any other name will smell as sweet," a "scientific" stone will be as good by any other name than its right one. When synthetic yellow sapphire is called "scientific topaz," perhaps no serious fraud is perpetrated, although it is misleading, but when artificial white sapphire is openly and deliberately sold at a fancy price as "synthetic diamond," with the support of the press, I for one consider that matters are going too far, and that this is being done at the present moment anyone can verify for himself. All these misrepresentations may bring wealth to individuals, but they tend to bring into disrepute the artificially-produced gem, and instead of allowing it a place of its own as a distinct achievement, cause it to be looked upon as a spurious make-believe.

However, I did not come here for the purpose of discussing this aspect, and I will not dwell upon it further. I have, as far as possible, given you a *résumé* of the whole subject, and I will detain you no longer, except, if I may add one more word, to acknowledge the fact that my ability to bring this paper before you is very largely due to the assistance I have received in many quarters, and more particularly from Mr. E. Hopkins, whose enthusiasm on the subject of the technology of precious stones is only exceeded by his knowledge and experience. I am indebted to him, not only for much advice and information, but also for the loan of the specimens from which I have prepared the illustrations to this paper.

DISCUSSION.

The CHAIRMAN, in opening the discussion, expressed his great pleasure at having heard such an admirably clear paper, many of the points in which were new to him. It was the first simple account he had heard of the production of synthetic stones, and his first opportunity of witnessing such interesting and clearly intelligible pictures. Those towards the end of the lecture showed well the differences between the reconstructed and the natural stones, and those slides appealed more eloquently to an audience than any amount of written description. They were practically seen by the audience under the microscope. Mr. Heaton had reminded him (the speaker) of the occasion when he lectured before the Society

fifteen years ago, and it was a satisfaction to him that he had, at that date, been able to call attention to all the methods which had been mentioned that evening, even including X-rays, which had then just become available. He also said at the same date that he thought the time could not be far distant when sapphires could be produced as easily and perfectly as rubies were then beginning to be made. The difficulty seemed to be the reproduction of the peculiar blue colour. He also mentioned in his own lectures the refractometer, the simplest and most effective way of testing a stone by its refractive power. At the time it was a scientific instrument available only to the expert scientist; but Dr. Herbert Smith, with the aid of Mr. Steward, had now constructed an apparatus which was within the reach of any worker, and enabled him to determine, without special knowledge, the refractive index of a stone to a great degree of accuracy. If that were combined with the use of a heavy liquid for determining the specific gravity, it constituted an almost unerring means of determining whether the stone were natural or artificial. When, fifteen years ago, he spoke on the natural and artificial or reconstructed ruby being distinguishable by the air bubbles in the latter, he was only basing his remarks on a limited experience. He was glad to find that, despite all the efforts which had been made to approximate the artificial to the natural stone, that still remained an unfailing distinction. The question was a very interesting one, because of the light it might throw on the manner of production of the precious stones in the earth's crust. For instance, the description of the production of the diamond naturally bore a close resemblance to the manner of creation of the diamond in the masses of meteoric iron which fell from the sky. The research which had been devoted to the production of stones artificially, had pointed out the possibility of adding to the repertoire, for a beautiful series could be produced of which there were no parallels in Nature. Robert Boyle, in 1665, seemed to have been the first person to make scientific experiments on the distinction between artificial and natural precious stones, and he pointed out how important it was to use methods which did not destroy the stones; and for this, among other reasons, recommended the specific gravity as the test. He (the speaker) did not know why paste should be condemned because it was paste, so long as its true nature were known to the purchaser. He had long admired the charm of the Roman gems in the British Museum, and was interested to hear that they probably originated in Nubia. He had never seen anything which illustrated so clearly the reconstruction of rubies as Mr. Heaton's demonstration. He had imagined that the pedestal on which the material was fused was kept in rotation; he did not know whether that was no longer so. The lecture was not one of those which ended merely in talk; it was a scientific and expert exposition, and he hoped to hear criticisms and enquiries from those present, who might include many with practical experience of precious stones.

Mr. J. H. Steward declared that he had no expert knowledge of precious stones, but he had found the paper extremely interesting. His experience had been more in connection with instruments. Fifteen years ago he was present at the lectures given there by the Chairman, and he was much struck by the description of the refractometer, and he thought it would be a very useful instrument if it were further developed. Without knowing very much about it, he took it in hand, but was not quite so successful as he had hoped to be. But Dr. Herbert Smith, of the British Museum, happened to know that he was experimenting with it, and offered his assistance. With that assistance an instrument was evolved of great practical utility, not only for gem determinations, but in other industrial matters. Much gratitude was due to Dr. Herbert Smith for the care which he had bestowed on the improvement of the instrument.

Mr. E. Hopkins thought rarity had a great influence on the value assigned to stones, as in other matters, such as old books, china, furniture, etc. Other articles were quite as useful and valuable intrinsically, but rarity greatly enhanced the market price. Within the last three months two rubies had been sold in London for £1,200, notwithstanding the energy bestowed on the manufactured article. Although the pearl was a softer material than its artificial substitute, the price of that also had risen 50 per cent., and was still rising. Recently a law had become operative in Paris that all manufactured gems must bear the prefix "imitation"; the term "synthetic" was not deemed sufficient. That was, perhaps, carrying the matter rather far, but the energy at the back of the artificial article seemed to have made such a law necessary. White sapphires had been sold as diamonds, and, instead of 4*s.* or 5*s.* per carat, they had realised £5 per carat. One of the best safeguards was to require a detailed invoice with such purchases, as a precaution, especially as the prices differed so greatly, and so much fraud was being perpetrated in such matters.

Mr. B. J. Tully remarked that the slide of the ruby selected for showing on the screen had the structure technically known as "silk"; but such marking was not always present, and it was scarcely a typical test of the true ruby, though where a white sheen was seen on a specimen, it was a certain identification. The microscope was the only real test left, but it was unsatisfactory, as it could be used only for very thin and small specimens. The difficulty of making the sapphire originally was concerned with the colour; cobalt was used, and only by analysis of the real stone was cromium discovered as a constituent. The pretty slide of a pearl which was shown was that of a Scotch specimen; and it was the prismatic structure

in the centre which gave rise to the dull lustreless sheen. It was scarcely a typical specimen of Oriental pearl; the latter could not be ground down thin enough to form a microscopic section; it had a laminated structure, and would split into pieces in grinding. The beautiful slides shown were due to Mr. Heaton's ingenuity. Artificial stones seemed to have reached their zenith, and he hoped they would as quickly decline again. It was gratifying to know that natural stones were now increasing in price more than even they did when artificial stones were not in competition with them, and there was a greater demand for them. The action of one or two societies, and the exposures of fraudulent sales, would do much to reduce the number of artificial stones being worn.

Mr. Frank Stevens pleaded for greater accuracy of definition in the matter of precious stones and gems. Nowadays it was the custom to include among precious stones such things as pearls, which were an animal product, not mineral. He thought a gem should be held to be an engraved mineral, as distinguished from a precious stone which had been cut and facetted by the lapidary. He asked as to the possibility of procuring a synthetic jargoon by fusion of zirconium silicate in the blowpipe, so as to bring about the range of colour from deep orange-brown to apple-green.

Mr. W. S. Lockhart said that as he understood artificial gems always had air included in them, that would surely make a difference in their specific gravity. He had usually found that the smallest error due to this was apparent.

Mr. Heaton, in reply, said the Chairman's remarks were of great interest to him. He had not properly appreciated the work of Boyle on the specific gravity as a means of identifying precious stones. There was a legitimate place for paste for those who did not want to pay for real stones, so long as they understood what it was they were buying or wearing. The pastes mentioned by the Chairman came from Rome, but they were later than the Nubian ones. He shortened his historical account in order to spend more time on the practical side; the early history provided enough material for a lecture by itself. It was true that the revolving pedestal was used in the old apparatus for reconstructing rubies, but it was not necessary in Verneuil's ingenious process. Scientific tests gave much more than a mere opinion; they were always right, and often contradicted an expert opinion. That was most important in view of the skill of some of the imitators. With regard to the silky look, he took extreme examples in each case. It was very exceptional to find a natural ruby which had not some traces of the parallel structure or of inclusions. He did not agree with Mr. Tully that the microscope was not of much use; one could focus it to the centre of the stone, and by immersing the latter in a highly-refracting liquid one could examine the minutest detail of structure, and his own experience was that microscopic examination was of the greatest value. The pearl shown was not an Oriental one, because it was impossible to prepare a decent microscopical section of a proper Oriental pearl. With regard to the synthetical jargoon, the difficulty with all the silicate group was that one could not produce it artificially by the Verneuil process, because it would not then be crystalline but amorphous. Synthetic jargoon had been produced on a small scale by the process of crystallising out with a solvent, but it was not a commercial proposition to make the stones in that way. Zircon was not a very valuable precious stone; if it were rare it would be a serious competitor to the diamond; it had a high refractive index, and its optical properties were very good. With regard to alterations of specific gravity caused by inclusion of air, those could of course be detected if sufficient refinement of method could be achieved. But in the great majority of cases the alteration thus introduced would not be greater than those occurring in the natural stone through slight variations of composition.

On the motion of the Chairman, a vote of thanks was accorded to Mr. Heaton for his paper, and the meeting terminated.

THE LÖTSCHBERG TUNNEL.

The successful piercing of the lofty mountain range which lies to the south-west of the Jungfrau, and separates the Bernese Oberland from the Canton of Valais, is certainly a triumph of Swiss engineering skill and enterprise. It has broken the record in rock boring. The Lötschberg tunnel on the Berne, Lötschberg and Simplon Railway, now in construction, is designed to connect the network of northern Switzerland with the Italian lines. It will, when completed, form one of the principal approaches to the Simplon tunnel, and shorten the distance between Calais and Milan, *viâ* Bâle and Berne, by about fifty-three miles, reducing the time required for the journey by at least three hours.

On the north side, the new line starts from the station of Frutigen (Berne), and, following the course of the Kander River, will enter the tunnel at Kandersteg. From the southern end at Goppenstein, the line winds along the steep mountain-side of the Lötsch-Thal, passing through no fewer than twenty-one tunnels and over ten important viaducts, reaching the Rhône valley near Gompel, and, following the course of the river, will join the Simplon railway near Brigue. The works of this line are being carried out by the "Entreprise générale du chemin de fer des Alpes Bernoises."

The Lötschberg tunnel was commenced on October 16th, 1906, and is 14,535 metres 41 centi-

metres in length (9 English miles). The junction of the two headings was made on March 31st last, and so accurately had the work been planned and carried out by the engineers in charge, that the deviation in the line of the tunnel was found to be only 257 millimetres (10·12 inches); the difference in the levels 102 millimetres (4 inches); whilst the length was found to be 41 centimetres (16·14 inches) shorter. The piercing of the mountain has occupied exactly 53½ months. Its construction has been attended with many difficulties.

Of the four great Alpine tunnels, the Lötschberg will, when completed, be the third as regards length, the longest being that of the Simplon, which is 9¼ miles, and occupied about eight years in construction; it was opened in 1905.

The St. Gothard tunnel, opened in 1880, the second in length, is 14,920 metres (9¼ miles) in length, and occupied 111 months in construction; whilst the first of the great Alpine tunnels, opened about forty years ago, is 12,133 metres (7½ miles) long.

The average length of heading driven from both sides daily was 12·46 metres (40·35 feet). The daily average on the north side, for which the Meyer rock-boring machinery was used, was 7·84 metres (25·72 feet), whilst the progress made on the south side, where the boring was done by the Ingersoll drills, averaged 5·12 metres (16·8 feet). On the north side, the greatest distance tunnelled in a single day was 13·20 metres (43·3 feet) in the limestone, and 10·60 metres (34·77 feet) in the granite. The average length driven per month was 310 metres (1,017 feet) in limestone, and 261·80 metres (858·92 feet) in granite. The daily average for the same period was 10·69 metres (35·07 feet) in limestone, and 8·95 metres (29·36 feet) in granite.

EMPIRE NOTES.

British Trade with Canada.—A Blue Book has just been issued by the Board of Trade embodying a report by H.M. Trade Commissioner for the Dominion of Canada. The report presents a general survey of the prevailing conditions in Canadian markets, and also gives a number of tables and figures indicating the expansion of Canada's trade, and describes the business methods of the representatives of the different nationalities competing for a share in the industrial and commercial development of the Dominion. A section of the report provides an analysis of the import trade of Canada, making special reference to the relations of American and British producers to the Dominion market. The Commissioner points out that there is a keen and unremitting struggle going forward along the whole line of British and American competitors for the trade of that country. The United States, of course, possesses an advantage from its geographical position, and the close social intercourse existing between a large section of its people and those of Canada, and also from the cheapness of communication. On the other hand, Great Britain profits by the preferential customs granted thirteen years ago, and by the long-standing connection between the British producer and the Canadian consumer, and by the high reputation for excellence of quality and workmanship and businesslike dealings which have given her pre-eminence in the markets of the world. While it may be said that British trade with Canada, in manufactured goods, is holding its own with America, it is pointed out that there are some trades which are not doing so. The reason for this is not attributed to the lack of quality in British goods, but in the failure to adapt them specially to the Canadian market. The Commissioner points out that in respect to capital, the investment of American money in British Columbia is noticeably large, and at least half of the capital employed in the mines of that province comes from the United States. Against this there is to be placed the large influx of British capital, which is widespread throughout the Dominion. Many instances are also given in which British goods are more than holding their own, and the report shows that if up-to-date methods of fostering trade are adopted by British manufacturers they need not fear any competitors.

British Trade with Australia.—Mr. C. Hamilton Wickes, H.M. Trade Commissioner for Australia, when interviewed recently, gave some interesting particulars of British trade with Australia. He stated that the imports into Australia of goods from all countries in 1908 totalled £49,799,273; in 1909, £51,171,896; and in 1910, £59,456,238. The goods of British origin in 1908 amounted to £25,274,661 or 50·76; in 1909, £25,862,618 or 50·54; and in 1910, £29,877,209 or 50·25. "That shows," he said, "that the increase in 1910 was £4,014,591, which is enormous. The trade of our two chief competitors in 1909 is represented by a total of imports from the German Empire of £4,538,612, and from the United States of £5,935,740. The increase of goods of British origin in 1910 was therefore, in round figures, within half a million of the total German imports into Australia for the previous year. Apparently Great Britain shows a decrease of the total imports, but in this total of imports by the Commonwealth are included such items as timber, kerosene oil, rubber, raw tobacco, tea, coffee, cocoa beans, fresh fruit, fresh vegetables, fresh fish, and rice, articles which England does not and could not produce, and never will produce. When you come to examine what the trade of Great Britain is, and the percentage of British trade with Australia, deducting these items, you will find that the British share has increased over 63 per cent., and instead of showing a decrease over 1908-9 it shows an increase."

Oil Fuel for the Australian Navy.—The scheme of Australian defence recently promulgated by Admiral Sir Reginald Henderson, will involve the

Commonwealth Government in the expenditure of a large sum of money annually for maintenance, in addition to its initial cost. To meet the necessary outlay, which the Government are quite ready to do, the question of the relation of the scheme to the trade and industry of the country is one of importance. It is interesting, therefore, to note that a contract is being placed with the Commonwealth Oil Corporation for the supply of oil fuel for the navy. Discussing this matter in the House of Representatives, the Hon. G. F. Pearce, Minister of Defence, who has recently made a thorough inspection of the works of the Corporation, said:—"I am thoroughly satisfied, from the businesslike preparation they are making, and the extent of the works, that there can be no doubt that in a short while they will be able adequately to supply all our requirements in the way of oil fuel for defence purposes. No one could go through the trip I have just accomplished without being impressed with the value of the industry to Australia from a commercial point of view. I think very few people realise the value of the shale-oil industry, or what its possibilities are." It is estimated that the oil industry will find employment for many thousands of workers.

Trade, Commerce, and Mining in Rhodesia.—Satisfaction is being expressed everywhere throughout Rhodesia at the excellent position which is revealed by the official figures for Rhodesian trade for 1910. The imports by Southern Rhodesia of United South Africa products amounted to £467,907, against £438,660 in 1909, and of £2,318,414 other than South African products, as against £1,775,345 in the previous year. Of the latter, 64 per cent. was imported from the United Kingdom, 4·1 per cent. from other parts of the British Empire, and 31 per cent. from foreign countries. The value of the exports of Southern Rhodesia for 1909 was £2,801,811, and for 1910, £2,797,906; the value of goods re-exported for 1910 bringing the total to £3,199,956. North-western Rhodesia also shows an appreciable increase on 1909, and the mining industry of Rhodesia is in a similarly satisfactory condition. At the annual meting of the Chamber of Commerce, the President stated that if the requirements for labour were satisfied, there would in five years' time be 80,000 natives employed in Rhodesian mines against 30,000 at present. Two new companies were registered in Southern Rhodesia during 1910, the nominal capital of which is about one million and a quarter. The dividends of the various mining companies amounted in 1910 to £905,999, as against £481,000 in 1909. The value of the output from small gold claims registered in 1910 was £76,687, or over £46,000 more than in the previous year. Capital is being found for development work in the mines which, at depth, are proved to possess permanent and continuous ore bodies.

Indian Industries.—A novel industry appears to be on the eve of development in India, where oil of good quality is being produced in considerable quantities from boiled sardines on the west coast of Madras. It is asserted that it is suitable for the jute, leather, and steel (tempering) trades, and for many other operations. The oil is said to contain a large amount of fish tallow (stearine). According to the Director-General of Commercial Intelligence at Calcutta, one of the most important industries of the country, that of wood-pulp, is showing marked signs of progress. Eight paper-mills are in operation, whilst others are approaching completion. The value of the output for 1909 amounted to £516,666, which is the highest on record. The wheat export from the Bombay Presidency was on an exceptional scale during the season 1909-10, the shipments being the largest for many years past. On the other hand, there has been considerable depression in the cotton and spinning industry, owing largely to the high prices ruling for raw material, and in part to the competition of imported goods, which was an adverse factor of some moment.

HOME INDUSTRIES.

Unemployment Insurance.—The Chancellor of the Exchequer's scheme of social insurance will shortly be unfolded, and although some of its main provisions are known, its full presentment is awaited with very deep interest. It is to cover sickness and invalidity completely, and it is said that it will touch unemployment. German pioneer work will help the Chancellor in his attempt to solve the problems of maintenance during sickness and infirmity, and the German system of joint contributions from the employer, the employed, and the State, is to be followed. But formidable as are the difficulties to be faced in the endeavour to create a satisfactory system under these two heads of insurance, they are much less so than those which will confront the Chancellor if he attempts to legislate for insurance against unemployment. Irregularity of employment is the most pressing evil of the present industrial system, and is clamant for a remedy. The unemployed may be divided into (*a*) those who cannot work owing to age or ill-health; (*b*) those who are incompetent owing to habits; (*c*) those who are able and willing to work but are unemployed from lack of demand. Class I. will be covered by sickness and invalidity benefits and old-age pensions; class II. need punishment rather than help; it is class III. with which unemployment insurance must be mainly concerned. There are no statistics available on which to found a rigidly accurate actuarial scheme, and even if they were available they would not necessarily form a trustworthy basis for the future. Taxation, emigration, increase of population, improvement in machinery and methods of working, relations with the colonies and other countries, all these and many other considerations must have their bearing upon the result of any possible legislation. It is safe to say that no system of unemployment insurance can either

be a preventive or a cure of the evil, but a well-devised scheme that will help the needy and worthy workman in the days of unemployment is not perhaps too much to hope for. But it is difficult to see how this gigantic subject can be satisfactorily dealt with by Parliament whilst it is in the throes of a great constitutional struggle. And better no legislation on such a subject than any which has not been thoroughly thought out and fully discussed.

The New Mines Bill.—The Coal Mines Bill has now entered upon the Committee stage, after being the subject of separate and joint conferences of the coalowners and miners. There will be keen fighting in Committee over several of the clauses. One of the stiffest fights is likely to be on Clause 60, which imposes restrictions on the use of electricity in mines. The opponents of the use of electricity in the coal-mining industry are to be found on both sides, some colliery owners and managers being as keenly opposed as are some of the men. In certain mines there is practically a complete absence of inflammable gas in the airways and working places, and here electricity has been accepted by managers and workmen, but the West Stanley disaster in Durham, and the explosion at the Hulton Colliery in Lancashire, have deepened the distrust of the workmen as to the safe use of electricity in mines. Clause 60 authorises the inspector of the district to enforce the withdrawal of an existing supply of electricity from any mine, subject only to an appeal to arbitration, but this does not satisfy the opponents of electricity, who want to see it withdrawn from all mines. Another clause, of much less real importance, is likely to be the subject of hot debate, namely, that which makes compulsory the provision of bathing accommodation at all collieries. The colliery baths in Germany have proved a distinct gain to the miner, but the colliery owners contend that the obligatory use of the bath by every workman before he leaves the colliery will be an endless source of irritation between the management and the men. The younger men may be willing to adapt themselves to the new conditions, but it is pretty safe to say that they will be resented and resisted by many of the older miners.

Electricity and Colliery Accidents.—In connection with electricity in mines a paper written by Mr. Robert Nelson, H.M. Inspector of Mines, appears very opportunely. Mr. Nelson reviews the accidents and deaths due to electrical causes recorded during the six years ending December 31st, 1910. These he divides into three divisions, (1) ignitions of firedamp, (2) underground fires, and (3) electric shock. There were five fatal ignitions of firedamp, giving rise to thirteen deaths; and in each case it appeared that the presence of gas was unsuspected. Two fatal underground fires and two deaths were recorded. In each case the insulation of the cable and the presence of woodwork aggravated the fire. One fire arose from the sparking of a continuous-current motor, and the other probably originated in the oil-switch of a three-phase motor. Electric shock was responsible for fifty-three accidents and fifty-five deaths, thus greatly outnumbering other electrically-caused accidents. Of the accidents, twenty-two were due to defective or non-existent earthing of electrical cables and apparatus, twenty were due to defective insulation of cables, nine to contact with uninsulated parts, and two to other causes. Of the twenty-four accidents on cables, twenty occurred on unarmoured cables, thus showing the urgent necessity for enclosing all cables and, as far as possible, all other underground electric plant in efficiently earthed armouring. As regards the influence of current, thirty-three out of the fifty-three accidents occurred on three-phase systems and twenty on continuous current. It would seem that proper protective methods may be relied upon to eliminate most of the dangers arising out of electricity in mines.

The Break-up of Estates.—Whatever may be the explanation—and authorities differ as to it—there is a tendency just now on the part of great owners to sell portions of their estates. Not long ago it was announced that Mr. Walter Long, whose family has been established in Wiltshire for several centuries, had decided to sell something like half his Wiltshire estates. Since then many other considerable landowners, notably Lord Onslow, have followed suit, and now it is announced that the Duke of Bedford is about to sell nearly the whole of his estates in Devonshire. It may be hoped that the tenants, or most of them, will be able to buy, since two-thirds of the purchase-money can remain on mortgage if desired. In Norfolk, an estate of 5,240 acres, of which more than 3,000 consist of agricultural land, is in the market; in Suffolk an estate of 6,000 acres is to be divided up and sold in lots; and in Shropshire a property of 3,500 acres will shortly be the subject of an auction. Lord Ilchester is getting rid of his estates in Hampshire and Wiltshire, and other landowners are mentioned as having the intention to sell very shortly. If these estates pass into the hands of competent and solvent occupiers the change may be welcomed. A single change of ownership would, more likely than not, be a disadvantage to the tenantry. The big landowners, whose families have been associated with the land for centuries, are usually generous landlords, the "new men," more frequently than not, are the contrary.

Bogus Banks.—A very much wanted Bill has been introduced in the House of Commons, having for its object the restriction of the use of the term "bank" to *bonâ fide* banks, undertakings of sufficient importance and stability to entitle them to use it. During recent years all kinds of commercial undertakings for lending and borrowing money have called themselves "banks." There

have been "loan and discount banks," "land and investment banks," "building banks," "financial banks," and other variations. Some of these have been stable concerns, honourably conducted, but most of them have assumed the title of "bank" merely to obtain credit on insufficient capital. The public, more especially the working classes, usually ignorant in such matters, have been the chief sufferers. The difficulty is to define a "bank," and to distinguish between a *boná fide* bank and one not entitled to use the word. Major White's Bill provides that every person, not being a limited company, who commences to carry on the business of banking after the Act, shall deposit with the Board of Trade £20,000, to be invested in trust securities, and to be available for satisfying creditors. An annual balance-sheet, and profit and loss account, must be prepared, and every five years an independent investigation must be made for the Board of Trade into the financial condition of the concern. Whether the Bill would be adequate to accomplish its object, whether it might not encourage the public to assume the solvency of the concern to be guaranteed by the Government, when in fact it was not, are points upon which opinion will be divided, but whatever the merits of this particular Bill, its object cannot be too highly commended; and it ought not to be above the capacity of our legislators to stamp out the bogus "banks," which, by means of an honoured name to which they have no right, prey upon a credulous public.

Australian Shipping Laws.—It may be assumed that the Federal Ministers now on their way from Australia will be empowered and instructed to discuss with the Imperial Government the provisions of the Australian Navigation Bill. The protest made by the Liverpool Shipowners' Association has been seriously considered by the Federal Government, but it is not at present prepared to make all the concessions asked for. The principal clause objected to is 206, which enacts that "a steamship in respect of which a certificate of survey, granted or recognised by the Board of Trade of the United Kingdom, has been issued, shall, while that remains in force, be exempt from survey under this Act." The Board of Trade would like to see the exemption extended so as to cover all vessels holding Lloyd's or the International Registry's classification survey status, but the Australian Government are reluctant to concede this point.

OBITUARY.

James George Henry Glass, C.I.E. — Mr. J. G. H. Glass died at Naples on the 21st inst. Born at Bracadaile, Isle of Skye, in 1843, he entered the Indian Public Works Department in 1862, and was posted to the Central Provinces. In 1885 he was appointed Provincial Secretary of the Department, a post which he held for nine years in combination with the chief engineership. He was created a C.I.E. in 1890; four years later he was transferred to the United Provinces as chief engineer and secretary of the buildings and roads branch; and in 1896 he was again transferred to Bengal, where he acted in a similar capacity. He was a member of the Lieutenant-Governor's Council. He retired from the service in 1898, and on his return to this country he served on the board of visitors of Cooper's Hill Indian Engineering College until it ceased to exist.

Mr. Glass became a member of the Royal Society of Arts in 1900. He wrote a paper on "The Great Landslip at Gohna, in Garhwal, and the Measures adopted to Prevent serious Loss of Life," which was read before the Indian Section in 1896, during the author's absence in Bengal, where he was then Chief Engineer and Secretary of the Public Works Department. He received the Society's silver medal for the paper.

GENERAL NOTES.

The Turin International Exhibition, 1911.—Great activity is being displayed at the present time in every department of the exhibition at Turin in order to have all in readiness for the opening, which will take place on the 29th inst. The "International Exhibition of Industries and Work," as it is entitled, besides occupying the whole of the gardens of the Valentino Castle, on the left bank of the Po, extends for a distance of three kilometres (nearly two English miles) on both sides of the river, covering an area four times greater than that of the last exhibition, held in the same gardens in 1898. Here are situated the principal exhibition buildings, which comprise the gallery of machinery in motion, and that of electricity, together occupying an area of 60,000 square metres (14¾ acres). The galleries allotted to chemical and extractive industries, manufactures, silk, public works, railways, etc., cover about 70,000 square metres (17 acres). The British section occupies a prominent position in these gardens, covering an area of about 20,000 square metres (nearly five acres). The Hungarian section, which is also on the same side of the river, is considerably less in extent, occupying about two acres. Among the other many attractions on this side of the river may be mentioned the "Palace of Fashion," the palace of journalism, the exhibition of musical instruments, and the great Hall of Festivals. The buildings erected by the other nations are mostly on the right bank of the river, the space allotted to some of the principal countries being: France, 14,000 square metres (3 acres); Germany, 30,000 square metres (nearly 7½ acres); Belgium, 6,000 square metres (1½ acres); Russia and the United States, 8,000 square metres (about 2 acres) each, whilst the exhibits of the other nations are proportionately less extensive.

Altogether the total area covered by buildings is estimated at upwards of 400,000 square metres (about 100 acres). In addition to the two existing stone bridges over the Po, viz., the "Ponte Umberto I." and the "Ponte Isabella," communication between the two sides of the river is established by the fine monumental bridge, provided with a moving platform, above which is a second roadway. Two aerial transporters worked by electricity also cross the river, where an efficient service of motor-launches for conveying passengers is provided.

Export of Raw Silk from Japan.—The quantity of raw silk exported from Japan to Europe has increased steadily during the last five years. The following figures give the number of bales shipped from that country during the six months ending December 31st, 1910, as compared with those of similar periods of the previous years:—

	No. of bales exported to Europe.	America.	Total.
1906	20,162	48,650	68,812
1907	22,893	40,041	62,934
1908	18,698	53,314	72,012
1909	27,990	51,508	79,498
1910	26,421	63,003	89,424

Opossum Farming in Australia.—On account of the recent rising market for opossum skins in Australia, chiefly because of their large export, especially to the United States, much attention is now being given to the possibility of breeding opossums for their fur in timbered parts of Australian farms. Several experiments of this kind have already been tried profitably. It is apparent that the future demands for Australian opossum skins can only be met by carefully breeding these animals commercially. An interesting suggestion in connection with the possibilities of opossum farming has been made by the Director of the Zoological Gardens at Sydney. He believes that every eucalyptus tree on Australian farms can be made productive by providing food for opossums, and that for every good-sized gum or eucalyptus tree the income of the farm might be increased by about two shillings. He is of opinion that a proportion of one male to three or four females would be an economical number to have, and that a simple method of keeping stock would be to place a number of small boxes, large enough to hold one opossum, in the trees and in an accessible position. The opossums would use these to sleep in during the daytime, when it is their habit to sleep, and the boxes would make it convenient to catch and examine them. The cultivation of maize and of chief fodder crops is also recommended in order to increase the opossum-carrying capacity of the farm and to enable the opossums to reach maturity more quickly. The chief food of the animals, however, is eucalyptus leaves, which in Australia, the native home of the eucalyptus tree, are naturally very abundant.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

May 3.—A. W. Gattie, "Improvements in the Transport and Distribution of Goods in London." James Swinburne, M.Inst.C.E., F.R.S., will preside.

May 10.—Hal Williams, M.I.Mech.E., M.I.E.E., "Beet Sugar Factories."

May 17.—Professor Raoul Pictet, "Les Basses Températures."

May 24.—Frank M. Andrews, "Architecture in America." Sir Aston Webb, C.B., R.A., F.R.I.B.A., will preside.

Indian Section.

Thursday afternoon, at 4.30 o'clock:—

May 25.—W. R. H. Merk, I.C.S., C.S.I., LL.D., "The N.W.F. Province of India."

Colonial Section.

Tuesday afternoon, at 4.30 o'clock:—

May 9.—F. Williams Taylor, "Canada and Canadian Banking." His Grace the Duke of Argyll, K.T., G.C.M.G., G.C.V.O., will preside.

Cantor Lectures.

Monday Evenings, at 8 o'clock:—

Alfred E. H. Tutton, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

Syllabus.

Lecture I.—May 1.—*The External Form of Rock Crystal and Chemical Character of its Substance.* Early Observations of its Geometrical Shape, and Conclusions drawn therefrom as to the Nature of Crystals in General—The Modern Conception of a Crystal—Measurement of the Angles between the Faces of a Quartz Crystal, and the Facts thereby Deduced—The Plan or Scheme of Arrangement of the Faces, and the Occurrence of Right and Left-handed Varieties of Quartz.

Lecture II.—May 8.—*The Internal Structure of Rock Crystal, and the Means we possess of Elucidating it.* The Chemical Molecules of Silica, and their Arrangement in a Space-lattice — The Influence of the Arrangement of the Elementary Atoms in the Molecule of Silica in Determining a Right or Left-handed Screw Structure—The probable Disposition of the Atoms and Molecules in the Right and Left Varieties of Quartz, and the Effect of this Internal Structure in determining the Outward Geometric Form—Revelation of the Oppositely Helical Structure by Etching and Liquid Cavities.

Lecture III.—May 15.—*Optical Evidence of the Two Complementarily Opposite (Mirror-image) Screw Structures.* Rotation of the Plane of Vibration of Polarized Light in Contrary Directions by the Two Varieties of Quartz—Experiments on the Artificial Reproduction of the Quartz Phenomena, in proof of the suggested Screw Structure—The Twinning of Quartz and Apparent

Enhancement of the Symmetry and Destruction or Modification of the Optical Activity thereby—The Interesting Case of Amethyst—The Magnificent Polarization Phenomena of Twinned Quartz.

LECTURE IV.—MAY 22.—*Scientific and Industrial Uses of Rock Crystal.* Its Thermal and Electric Properties, and its Transparency to Ultra-violet Rays—The Construction of Prisms and Lenses (including spectacles) of Rock Crystal, and their Advantages over Glass—The Use of Quartz for Balance Weights and in connection with the Interferometer—The Artistic Use of Quartz for the Carving of Vases and other Objects—Destruction of the Crystalline Structure by Fusion, and the Uses of Fused Silica in Fibres and Scientific Apparatus.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 1...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Dr. A. E. H. Tutton, "Rock Crystal—its Structure and Uses." (Lecture I.)

Farmers' Club, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mr. H. Trustram Eve, "Agricultural Land and Local Taxation."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 7.30 p.m. Mr. H. C. H. Shenton, "The Protection of Water-Supplies."

Chemical Industry (London Section), Burlington House, W., 8 p.m. Mr. C. Edward Sage, "The Testing of Creosote."

British Architects, 9, Conduit-street, W., 8 p.m. Annual General Meeting.

Actuaries, Staples Inn Hall, Holborn. W.C., 5 p.m. Mr. T. Bradshaw, "Notes on the Insurance Act, 1910, Dominion of Canada."

Concrete Institute, International Building Trades Exhibition, Olympia, West Kensington, W., 5.45 p.m. Mr. R. W. Vawdrey, "Reinforced Concrete." (Lecture I.)

Economics and Political Science, London School of, Clare Market, Kingsway, W.C., 8 p.m. Mr. W. M. Geldart, "Legal Powers and Limitations of Trades Unions."

TUESDAY, MAY 2...Sociological, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. George Paish, "Savings and the Social Welfare."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. J. E. C. Bodley, "The Decay of Idealism in France and of Tradition in England."

Alpine Club, 23, Savile-row, W., 8.30 p.m.

Economics and Political Science, London School of, Clare Market, Kingsway, W.C., 8 p.m. Mr. J. H. Morgan, "The Legal Liability of the Executive."

Faraday Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. 1. Mr. A. Scott-Hansen (Christiania), "Hydro-Electric Plants in Norway and their Application to Electrochemical Industry." 2. Mr. Verdon Cutts, "Electro-Metallurgy in the Steel Foundry." 3. Mr. Edgar Stansfield, "Two Simple Forms of Gas-Pressure Regulators."

WEDNESDAY, MAY 3...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. A. W. Gattie, "Improvements in the Transport and Distribution of Goods in London."

Public Analysts, at the Chemical Society's Rooms, Burlington House, W., 8 p.m. 1. Messrs. J. C. Umney and C. T. Bennett, "The Evaluation of Certain Spices used in Medicine." 2. Mr. Edward Halliwell, "Absorption of Dissolved Oxygen by Sewage Effluents and the Royal Commission's Provisional Standard." 3. Dr. G. D. Lander and Mr. A. E. Walden, "The Detection of Traces of Hydrogen Cyanide." 4. Messrs. A. E. Parkes and J. D. Roberts, "Note on the Composition of 'Blaud's Pills'"; "Note on the 'Pearl Coating' of Pills." 5. Mr. J. F. H. Gilbard, "A reaction for 'Caulophyllin.'"

Royal Archæological, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Miss E. K. Prideaux, "The Sculptured Figures on the West Front of Exeter Cathedral Church."

Economics and Political Science, London School of, Clare Market, Kingsway, W.C., 5 p.m. Sir John Cockburn, "The Referendum in Australia."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 5.45 p.m. Mr. R. W. Vawdrey, "Reinforced Concrete." (Lecture II.)

THURSDAY, MAY 4...Antiquaries, Burlington House, W., 8.30 p.m.

Linnean, Burlington House, W., 8 p.m. 1. The Rev. T. R. R. Stebbing, "On John Vaughan Thompson and his Polyzoa, and on *Vaunthompsonia*, a genus of Sympoda." 2. Professor Sydney J. Hickson, "On *Polytrema* and some allied genera." 3. Mr. J. M. Brown, "Observations on some new and little-known British Rhizopods. 4. Mr. R. Shelford, "The British Museum collection of Blattidæ enclosed in Amber." 5. Dr. F. E. Fritsch, "Freshwater Algæ collected in the South Orkneys by Mr. R. N. R. Brown."

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. F. B. Power and C. W. Moore, "The Constituents of Bryony Root." 2. Messrs. H. Leete and E. de B. Parnett, "Note on the Action of Hydrogen Dioxide on Thiobenzanilide." 3. Mr. K. J. P. Orton, Miss M. G. Edwards, and Mr. H. King, "Purification of Acetic Acid." 4. Miss M. G. Edwards and Mr. K. J. P. Orton, "The Detection and Estimation of small quantities of Acetic Anhydride in Acetic Acid." 5. Messrs. P. C. Ray and H. K. Sen, "Tetramethylammonium Hyponitrite and its Decomposition under Heat." 6. Messrs. G. Senter and A. W. Porter, "Reactivity of the Halogens in Organic Compounds. Part VI. The Mechanism of Negative Catalysis." 7. Mr. E. B. R. Prideaux, "The Second and Third Dissociation Constants of Orthophosphoric Acid." 8. Messrs. F. B. Thole and J. F. Thorpe, "Experiments on Tautomerism. Part I. The Tautomerism of the System X−CHR−CR=CR−X, showing the identity of the α- and γ- Positions in the Glutaconic Acid Molecule."

Royal Institution, Albemarle-street, W., 3 p.m. (Tyndall Lecture.) Professor R. W. Wood, "The Optical Properties of Metallic Vapours." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. C. E. Keyser, "Norman Dorways of Gloucestershire."

Philatelic, 4, Southampton-row, W.C., 6 p.m. Mr. T. W. Hall, "The Early Issues of Chili."

Roentgen Society, 19, Hanover-square, W., 8.15 p.m.

FRIDAY, MAY 5...Royal Institution, Albemarle-street W., 9 p.m. Professor Martin O. Forster, "New Organic Compounds of Nitrogen."

SATURDAY, MAY 6...Municipal and County Engineers (Eastern District Meeting), Guildhall, Cambridge, 11.30 a.m. 1. Mr. Julian Julian, "Cambridge from a Municipal Engineer's Standpoint." 2. Visits to Municipal Works, etc.

Royal Institution, Albemarle-street, W., 3 p.m. Professor Selwyn Image, "William Morris: or, the Craftsman and Art." (Lecture II.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MAY 8TH, 8 p.m. (Cantor Lecture.) ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." (Lecture II.)

TUESDAY, MAY 9TH, 4.30 p.m. (Colonial Section.) F. WILLIAMS TAYLOR, London Manager of the Bank of Montreal, "Canada and Canadian Banking." His Grace the DUKE OF ARGYLL, K.T., G.C.M.G., G.C.V.O., will preside.

WEDNESDAY, MAY 10TH, 8 p.m. (Ordinary Meeting.) HAL WILLIAMS, M.I.Mech.E., M.I.E.E., "Beet-Sugar Factories." The EARL OF DENBIGH, C.V.O., will preside.

CANTOR LECTURE.

On Monday Evening, May 1st, Dr. ALFRED E. H. TUTTON, M.A., F.R.S., delivered the first lecture of his course on "Rock Crystal: its Structure and Uses."

The lectures will be published in the *Journal* during the summer recess.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

CONVERSAZIONE.

The Society's Conversazione will be held, by permission of the Trustees of the British Museum, in the Galleries of the Natural History Museum, South Kensington, on Tuesday Evening, May 30th, from 9 p.m. to 12.

The Reception, by Sir JOHN CAMERON LAMB, C.B., C.M.G., Chairman, and the other Members of the Council, will be held in the Central Hall from 9 to 10 p.m.

A Selection of Music will be performed by the Band of H.M. Royal Artillery, in the Central Hall, commencing at 9 o'clock.

A Vocal and Instrumental Concert will be given in the Fish Gallery and a Miscellaneous Entertainment in the Shell Gallery, under the direction of Mr. PATRICK KIRWAN, commencing at 9.30 p.m.

The following portions of the Museum will be open:—

The Central Hall, containing cases of specimens illustrating Mimicry; Adaptation of Colour to surrounding conditions; Protective Resemblance; etc. Also specimens illustrating the Food of Fishes, and the Life History of the Eel (East of staircase).

The North Hall, containing the collection of Domesticated Animals.

The Bird Gallery, containing groups of British Birds and Nests; and in the Pavilion, at the West end, an exhibition of the Land and Fresh-water Vertebrate Animals of the British Isles.

The Fish Gallery, containing the Great Basking Shark, the grotesque Deep-sea Fishes (case 44), the Tunny (case 38), the Tarpon and Angler-fish (case 27), and the Lemon-Sole (case 30), etc.

The Shell Gallery, including a life-size model of a Giant Squid (Newfoundland), and of a Giant Octopus (California).

The East and West Corridors on the First Floor, containing the Okapi, African Antelopes, and Giraffes.

Light Refreshments will be supplied at Buffets in the North and South Corridors on the First Floor of the Museum.

Visitors travelling by the District Railway (or other underground railways in connection therewith) will be allowed free use of the company's subway, which leads from South Kensington Station direct into the grounds of the Museum.

Each member is entitled to a card for himself (which will not be transferable) and a card for a lady. (These cards will be issued shortly.) In addition to this, a limited number of Tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the day of the Conversazione. On that day the price will be raised to 7s. 6d.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary at the Offices of the Society, John-street, Adelphi, W.C. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

The Council reserve the right of stopping the sale of tickets or of raising the price, if it is found necessary, in order to restrict the number of visitors within reasonable limits.

Further particulars as to the musical and other arrangements will be given in the Programmes, which will be distributed on the evening.

PROCEEDINGS OF THE SOCIETY.

NINETEENTH ORDINARY MEETING.

Wednesday, May 3rd, 1911; JAMES SWINBURNE, F.R.S., M.Inst.C.E., Past-President Inst.E.E., in the chair.

The following candidate was proposed for election as a member of the Society:—

Beg, Mirza Faiz Husain, Kothi M. Abbas Beg, Kaiserbagh, Lucknow, Oudh, India.

The following candidates were balloted for and duly elected members of the Society:—

Cope, Thomas, 27, Rosenthal-road, Catford, S.E.

Das, J. N., F.R.G.S., M.R.A.S., Khalispur H. E. School, Khulna, Bengal, India.

Gibson, Captain R. R., Immigration Office, Essequibo, British Guiana.

Giveen, Richard Lockwood, Colet-court, Hammersmith-road, W.

The paper read was—

IMPROVEMENTS IN THE TRANSPORT AND DISTRIBUTION OF GOODS IN LONDON.

By A. W. GATTIE.

Sir Alexander Henderson, the Chairman of the Great Central Railway, stated eight years ago, in an address to his shareholders, that if overlapping in goods traffic in London could be avoided by a combination of only six of the railway companies coming into London, a saving of a considerable portion of £2,500,000 a year could be made by those railway companies. (See Appendix D.)

I have not Sir Alexander's figures before me, and I am, therefore, unable to tell you how this estimate was arrived at, but I have myself investigated this matter very closely, and I have come to the conclusion that if the work of goods handling and cartage in London were done on scientific lines, a gross saving to the community of at least £20,000,000 a year could be made in London alone.

Everything that applies to London would, of course, apply in varying degrees to our other densely-populated centres, and I am quite sure that I am within the mark in stating that an economy well within the reach of science can be made which would effect an annual saving of an amount more than equal to the entire government revenue of the United Kingdom. With such a statement before you, you will at once recognise that economy in transport is not a matter of interest to any group or groups, but is one of vital importance to every man, woman, and child. The cost of transport enters into the price of everything, and therefore must affect every producer and every consumer. This fact is apt to be lost sight of, because, if a man goes into a cheesemonger's shop to buy a pound of cheese, the cheesemonger tells him the price of that pound of cheese is 1s., and in due course the cheesemonger sends it round to the house of the purchaser, and makes no charge for delivery. As a matter of fact, however, the cheesemonger has charged so much for the cheese and so much for transport. It may surprise some people to know that while transport in the matter of some things is a very small percentage of the cost, yet in others it is a very high percentage. If we may take, as an important item, such a thing as wheat, we find that in 1868 the cost of conveying a quarter of wheat from Chicago to Liverpool was 11s. 6½d., whereas at the present moment it is 2s. 10½d., and you will see that in this one

important item a saving of 8s. 8d. has been made out of 11s. 6½d. This saving is due to improvements in means of transport. If a sum of 8s. 8d. can be saved in the transport of one quarter of corn, it is sufficiently obvious that by multiplying this figure by some millions, we may easily arrive at a very large sum. You will, therefore, see that by an economy analogous to the one I have already quoted, a saving of £200,000,000 a year is by no means out of the question.

The enormous saving which has been made in water-borne transport during the last forty years has been effected by improvements in machinery and by the economic system of management of shipping companies. This economic system of management, and the encouragement which has been given to marine engineers to improve their methods, is due to the fact that steamship companies have had to compete with one another; but in the matter of land transport, while there has been a certain competition between the bureaucracies governing railway companies, it has been a restricted competition of not the most healthy kind.

I must not be understood to say that the efficiency of the locomotive has not been improved; it has been enormously improved. Since the year 1850 it is interesting to know that the tractive power of passenger locomotives has increased 83 per cent., and the tractive power of goods locomotives has increased 97 per cent.; but despite the splendid results achieved by the locomotive engineers, goods transport has not improved. That means that the whole of the 97 per cent. improvement made by the locomotive engineer has been frittered away in bad management at terminals. Let us be under no misapprehension as to why goods transport in this country has remained the most expensive in the world. There are only two factors of cost—hauling and handling.

I have shown you in exact terms that the tractive power of the goods engine has almost been doubled; but, unfortunately, all the economies achieved on the track are squandered in the hideous waste of our terminal arrangements.

In an address to the London Chamber of Commerce last June, I promulgated the adoption of the principle of the Bankers' Clearing House to the business of transport. I showed how great a benefit the Clearing House has been to the banker, and I believe I succeeded in proving, by analogy, that it would be a benefit as great, or even greater, in the matter of transport.

The Bankers' Clearing House is a place where certain pieces of paper called cheques are collected and redistributed.

A Goods Clearing House is a place where truckloads of general merchandise, goods, bales of goods, and parcels, could be collected and redistributed. By general merchandise I mean practically everything except coals and cattle. In the Bankers' Clearing House pieces of paper called cheques pass from the hand of one clerk to the hand of another clerk, and the transference is completed. A clerk distributing a portmanteau full of cheques at the Clearing House might, by moving only a few yards, distribute parcels of cheques to twenty or thirty other clerks in less than a minute; but before the Bankers' Clearing House was established, that clerk would have had to walk round the whole of the City and call at twenty or thirty banks, a tour which would probably take him an hour or more. Thus it will be seen that out of sixty minutes, fifty-nine have been saved, and this saving applies to every bank admitted into the Clearing House.

Now for the analogy. Instead of the word "banker" let us use the word railway, or carrier, or trader. Instead of a portmanteau and a bundle of cheques, we will substitute a railway wagon, or a motor-van, and a load of bales, which may, perhaps, weigh three tons. It is, of course, quite easy for one man to hand to another a handful of pieces of paper, but in order to handle heavy weights rapidly and without concussion, modern apparatus is absolutely necessary. Therefore, instead of clerks, I propose to equip the Goods Clearing House with apparatus suitable for the purpose.

At the present moment I only wish to invite your attention to the enormous economy to the railway companies which would be effected by the adoption of this Bankers' Clearing House system, because it provides a place where railway companies can exchange loads with one another without shunting or marshalling, and consequently without the necessity of the enormous shunting yards which they now use. It is no exaggeration to say that these goods stations and shunting yards are, figuratively, bottomless lakes into which railway managers are throwing their shareholders' money, and the money of the community, by the sackful. But this is not merely a question of railway

economy; it is also a question, and an equally important and pressing question, of economy of van traffic in London streets. All traffic between goods stations would necessarily disappear, as the business could be done in one place; but, more than that, it is quite clear that both in taking goods to consignees and carrying them from consignors one vehicle only would be necessary where a great number are now used.

In the Address to the Chamber of Commerce above referred to, I drew particular attention to the existing condition of street traffic in London. Summarising my statement on that occasion, I showed that at least twenty vans were used to do work which on co-operative and organised lines might be done by one, and, turning to the use made of the railway wagon, I showed that even a worse state of things prevailed.

The life of a railway goods wagon is about seventeen years, and during that seventeen years it is only mobile on the track for six months—in other words, for sixteen and a half years out of seventeen that wagon is detained in loading, unloading, and shunting, and, as a consequence of the shunting, undergoing repair. This goods wagon may cost anything from £70 to £100, and the cost of keeping it in repair, at a very moderate estimate, would be £4 a year.

Well, if this goods wagon is standing for sixteen and a half years, it must be standing somewhere, and it is very often standing uselessly rotting in sunlight and rain on a very expensive piece of land. If you will look at the map on the wall, you will see I have marked the sites of these standing-places in red, and to enable you to form some idea of the large area they cover, I have coloured Hyde Park, St. James's Park, and various other parks in green.

With such figures, and such a map before you, you will, I think, realise that there is room for much improvement. It is quite clear that if, instead of using a railway goods truck for half-an-hour out of twenty-four hours, it could be used for a whole hour out of twenty-four hours, only half the number of wagons would be required to do the work, and only half the standing-place required to berth them.

Now railway companies own about 766,000 wagons, and these, at a low computation, must be at least worth £50,000,000. These wagons have to be renewed every seventeen or eighteen years at vast capital outlay, not to speak of maintenance. They are not worn out in use; they are worn out in disuse, and misuse. By the latter I mean the process known as shunting, which consists in bringing the vehicles into violent collision with one another. This process is dangerous to human life, it is damaging to railway property, and it is uneconomic, unscientific, and abominable from every point of view. It may be as well to explain by an example what shunting means, and why, under existing circumstances, it is necessary.

For instance, a goods train leaves Bristol for London, and it carries a number of wagons with what is called "through traffic," or traffic for other railways. On arrival at the shunting-yard at Willesden, called Old Oak Common, it will be necessary to split that train up into sections, and to push the various sections into sidings, one or more wagons going into each siding, each siding being set aside for a particular railway company.

Let us assume that one of these railway wagons was shunted into a siding, and is destined to go to a station on the London, Brighton and South Coast Railway. This wagon will not necessarily be immediately moved from Old Oak Common; it will wait in the siding into which it has been shunted, and after some hours this siding will get full of other wagons, also for the London, Brighton and South Coast Railway. Having waited, perhaps, six hours, and endured much banging, a Great Western engine will haul it, together with some thirty other trucks, to a shunting-yard called Lillie Bridge, at Brompton. It will be noticed that these supposed thirty or thirty-five trucks from the Great Western would be in no particular or desired order. They will simply be taken by the Great Western to the Brighton Railway at Lillie Bridge without any sorting whatever having been done, and without any sorting whatever being possible. At Lillie Bridge the process of marshalling will take place. The wagons in marshalling are picked up and dropped, and picked up and dropped, and banged together again, hour by hour, at Lillie Bridge, until the various goods trains on the Brighton system are made up in the proper order, and depart on their journeys.

I cannot help thinking that if these processes of shunting and marshalling were to give way to a scientific and economic substitute, everybody, railway companies, traders, and the community at large, would greatly benefit. Let us see how, with suitably

designed apparatus, it would be possible to deal with the train from Bristol I have already instanced.

According to the proposed Goods Clearing House regulations, all trains coming into it would be loaded in such a way as to permit of their burdens being lifted off the vehicles by cranes; these cranes would be of a special pattern, and capable of moving loads through all three dimensions of space. In this way the load of goods I have instanced as being shunted at Old Oak Common, and then carried to Lillie Bridge and marshalled, would go through none of these processes. The train would arrive at the Clearing House, and the load would be lifted from the Great Western train and put on to the Brighton train, if the Brighton train were there to receive it. If the Brighton train were not there to receive it, it would be put in an appointed place in the Clearing House, and would wait until the Brighton train was there to receive it, and it would then be placed in its right position on the Brighton train. In this very simple way this substitute for the work of shunting could be done at, I believe, 1 per cent. of the present cost in time, space, and labour.

The Goods Clearing House, however, would not confine itself to the mere transference of heavy loads. It would also be equipped for the rapid sorting of goods and making up of loads, and this work could be carried out at a speed of something like 2,000 bales a minute. I propose to go into this matter in further detail later on.

Nearly a year has lapsed since the delivery of my speech at the London Chamber of Commerce, and although it has been given the very utmost publicity in the daily press, and in newspapers varying in character from the *Drapers' Record* to the *Lancet*, and in a great number of technical papers of high standing, no one has accepted my invitation to amend the figures I then put forward. I have, however, been asked many questions, and one very persistently. How is it, it has been asked, if so great a benefit can be conferred on railway companies by your proposed reforms, that railway managers do not receive you with open arms? The directors of my company have been quite as puzzled on this subject as our questioners, and in order to clear the matter up, and enable me to give you some definite information on the point, we last month addressed the following letter to all the general managers and goods managers of the railway companies running into London:—

"Dear Sir,—The general managers of two railway companies coming into London have expressed the opinion that the project put forward by this company of establishing a Central Goods Clearing House in London is 'impracticable.'

"The directors of this company naturally attach considerable importance to this expression of opinion, and are, therefore, anxious to learn whether you endorse it.

"If that is the case, may we inquire whether you claim that the alleged impracticability consists in any of the following details:—

"1. The proposed electrical arrangements.

"2. The proposed mechanical arrangements.

"3. The proposed structural arrangements, and, if so, whether in the matter of the proposed approaches or in the structure and design of the building itself.

"4. The proposed system of sorting parcels, bales, or heavy loads of goods by automatic conveyors.

"5. The proposed clerical arrangements.

"6. The proposed arrangements for elimination of shunting and marshalling.

"7. The proposed arrangements for the manipulation of traffic.

"8. The proposed financial arrangements, and, if so, in what specific direction.

"Failing the discovery of any impracticability in the foregoing features, would you so far indulge us to let us know in what shape, form or function you discover the alleged impracticability?

"We should be very much indebted to you if you can see your way to do this, as we feel that the opinion expressed by the two general managers referred to must be due to a misconception or want of detailed information as to the proposals actually put forward by this company.

"We shall have much pleasure in answering any question you care to put to us, or in clearing up any point of objection if made in a specific form.

"Under separate cover we are sending you a copy of our chairman's address to the London Chamber of Commerce last June.

"The subject will be further discussed on the 3rd of May next at the Royal Society of Arts, and any railway gentleman will be, we know, heartily welcomed by that Society.

"Awaiting the favour of your reply,
"We are, Dear Sir,
"Yours faithfully,
"THE NEW TRANSPORT COMPANY, LTD."

I have received a variety of replies from the railway companies, but not one will give any endorsement to the opinion of the two general managers, who, without the remotest knowledge of any of the apparatus it is proposed to

employ, expressed the opinion that the project was "impracticable."

There are, however, two letters written from railway companies in which the writers confess themselves unable to offer an opinion, as they are without any detailed knowledge on the subject, and it is worthy of note that neither of these gentlemen expresses any anxiety to be enlightened. They do not say the scheme is "impracticable"; they merely say, under the conditions with which they are familiar, such a project would be impossible, and with this opinion, both I, and the group of distinguished engineers with whom I have the honour to be associated, are in full concurrence.

Without the necessary machinery, the Clearing House would be an impossibility.

In a conversation with one of the two general managers who have expressed the opinion of the "impracticability" of a goods clearing house, the question was raised as to how it would be possible to deal with the fish traffic coming in to London. This is one of the innumerable matters of detail which have to be dealt with in any proper consideration of this scheme. Vague generalities are worse than useless, and I am, therefore, going to take this subject which was selected by the railway manager, and explain it in unmistakable terms.

In reply to his inquiry I gave the following explanation :—

I told him that about 800 tons of fish arrive every day at Billingsgate, and of this 400 tons is water-borne, and 400 tons is carted from the various London goods stations by means of about 180 pair-horse railway vans. The bulk of these vans arrive at Billingsgate between three and four in the morning, and remain waiting in the precincts of the market for an average of over eight hours, when they depart, on their return journey to the railway stations whence they came, with loads of empty and very malodorous fish trunks. Owing to the presence of these vans during the long hours of their detention, retailers' carts are unable to come close up to the market place, and that disability involves the necessity of expensive porterage. I may here say that these porters who carry the fish trunks on their heads may earn as much as £3 a week. The disadvantages of such a state of things are quite obvious. I explained to this general manager that my proposal was that all fish trains, or all railway wagons carrying fish, should proceed to the Clearing House, and thence proceed to the proposed Clearing House wharf, *via* Snow Hill railway connection, as shown on the map in front of you.

You see that the wharf is situated between the railway bridge and the road bridge at Blackfriars, on the north bank of the river, and is only a two-minutes' run by rail from the Clearing House. The fish so conveyed would be packed either in trunks or in bulk, in suitable steel cage containers of about eight to ten tons capacity, and detachable from the railway wagons. On arriving at the wharf, these cages or containers would be lifted from the railway wagons by the cranes and lowered into specially designed fish barges, each of which would carry about 100 tons, and would be equipped with a view to facile unloading on arrival at Billingsgate. These barges would be reserved exclusively for this service, and on their return journey would bring away from Billingsgate all empty fish trunks in the returned containers. On arrival at the wharf on this return journey, the containers which brought the fish of the previous day would now be hoisted from the barges with their load of empties and dipped into a deodorising tank by the crane. The crane would then unload the newly-arrived fish from the railway wagon and place it in the barge, and would then load up with the cage of empty trunks for the return journey.

It will be seen that in this simple way London street traffic would be relieved of two journeys by 180 wagons and 360 horses. At the same time a great economy would be effected, because the loading up of the fish boxes at the goods station and the unloading of them on arrival at Billingsgate would be done away with, and the loading up of the empties into the vans and the unloading of them again at the goods station on the return journey would also be done away with. In addition to this great advantage, there would be the saving in space, and the retail fishmonger would be able to get near to the market place, which would no longer be blocked with the unnecessary vans.

The general manager in question was unable to see any advantage in the proposed method, which he declared to be impossible. I have, however, communicated with the Fishmongers' Hall, and have received an intimation that the matter will be considered at the next meeting of their council.

In considering the attitude of railway managers towards the Clearing House scheme, two important factors must not be lost sight of. The one is the immense force of habit of mind

and the other is the great progress which has been made in recent years in scientific apparatus. Railway managers are not men of science. The manager has been accustomed all his life to receive a goods train in London in the small hours of the morning, to have it unloaded clumsily, slowly, and arduously, by hand and hand-truck, and, having so unloaded it, to allow empty trains to cumber come fifty miles of sidings for about sixteen or seventeen hours, when some of these trucks are again loaded and despatched from London. We are all of us creatures of habit, more so than we realise, and the railway manager is no exception to the rule. Consequently he wants to know where we are going to store some 12,500 wagons for seventeen hours in the Clearing House. To store wagons in the Clearing House is utterly absurd and impossible; it has never been suggested, and it is by no means necessary. The necessity only exists in the mind of the railway manager.

Let us now see how this unnecessary waste of time, space, and rolling-stock can be avoided. Towards the end of the business day the clearing house would receive some thousands of tons of goods consigned to it by traders and manufacturers in London. The total amount of goods delivered by road during the whole day would probably amount to 25,000 tons, 15,000 tons of which would be for despatch by rail, and 10,000 for despatch by road. The greater quantity of the 15,000 tons would be received in the afternoon and evening, and would probably all be in hand by ten o'clock at night. By midnight the whole of these goods could be sorted and loaded up into containers. (Let me remind the audience, a container is a large box, or cage, or skip, designed to contain anything required.)

As soon after twelve o'clock as can be arranged, goods trains loaded with goods from every part of the country might begin to arrive at the Clearing House in ever-increasing numbers, hour after hour.

There are twenty-four working train berths in the Clearing House; each of these berths is 1,300 feet long, and therefore capable of receiving a train of about that length, if called upon to do so. These twenty-four berths are overhung and served by 240 electric travelling cranes, each crane being capable of hoisting five tons at a time. There are also six supplementary berths only accessible to the road level cranes. The arriving trains would be so loaded that their contents could be seized by these cranes and immediately hoisted into the Clearing House. Supposing that the cranes installed were able to work as rapidly as the steam crane now in use on Folkestone Pier, which every day hoists containers from the Channel steamers on to the railway wagons on the quay, we should be able to make a little more than one hoist per minute per crane. Our maximum hoisting capacity in the Clearing House would be, therefore, 240 loads per minute. Assuming that each load was about two tons, this gives us in round figures an unloading capacity of about 500 tons per minute. Having unloaded a train, the next thing to do would be to reload it from the store of goods already in the Clearing House and despatch it with as little delay as possible. It will thus be seen that trains arriving in the Clearing House can be unloaded and reloaded at a speed which is now utterly undreamt of by our friends the railway managers.

On Folkestone Pier they have themselves proved what can be done, but they have not learnt the lesson they have taught.

We will now consider in detail how trains might arrive at the Clearing House.

If you will look at the map before you, you will see there are three pairs of tubes, one going to the north, and serving a group of huge goods stations marked in red immediately above King's Cross. These goods stations are collectively about half a mile broad by three-quarters of a mile long, as nearly as I can measure it.

Another tube goes to the east and joins on to another enormous goods station, and a third goes south and links up the Clearing House, *viâ* Blackfriars railway bridge with South London, and it also links it with the River Thames, an avenue of approach by no means to be despised. It would present no difficulty whatever for trains to arrive at any of these three points, viz., King's Cross and St. Pancras, Bishopsgate, or Blackfriars, and to be there held for such number of minutes as might be convenient until the Clearing House was ready to receive them. A digest of the railway routes approaching the Goods Clearing House is printed in Appendix A., and eventually a time-table showing the hour of arrival and departure of each train will be drawn up.

At the present moment there are about 290 goods trains coming into London every day. It would be quite possible to receive these 290 trains through the three tubes shown. If each tube were to receive a train once in three minutes, the Clearing House would be supplied with one train a minute, and it could in the same

way despatch one train a minute, or one train by each tube at intervals of three minutes.

In this way it will be seen that the whole of the postulated traffic could be negotiated in 290 minutes, or less than five hours.

This is a considerable improvement on the methods in vogue. At one goods station where I have spent many hours in investigation, I find that by the hand and hand-truck method, 195 men were able to load 918 tons in seventeen and a quarter hours, the men working on eleven hour shifts.

I remind you here that Clearing-House speed can load up 500 tons a minute. It will, therefore, be seen that Clearing House loading speed is, as nearly as possible, 500 times as great as goods station speed.

I trust that what I have said will show that when the two railway managers said the scheme was impracticable, it was probably because they did not understand the possibilities created by the introduction of modern machinery into the matter of goods handling.

I think it is now clear how a speed such as I claim for Clearing House methods will easily account for the fact that the Clearing House would be able to do the entire work not only of the seventy-two goods stations, the larger of which you see marked in red on the map before you, but also of a very much greater number of receiving depots and carriers' yards, all of which are of the old-fashioned "ramshackle" type.

I remember on one occasion visiting the premises of one of our most important carriers, and I saw a man coming upstairs with a bale of goods on his back. I have never forgotten it.

I will now ask you to look at this diagram, which represents one of the great sorting floors in the Clearing House; this sorting floor is about as large as Lord's cricket ground, and the one above it, and just like it, is also about as large as Lord's cricket ground. These two floors are overhung by cranes; these cranes hoist container loads of goods from the railway beneath, or from the roadway beneath. The roadways consist of thirteen bridges running east and west, and these bridges span the railway tracks beneath, which run north and south. The bridges are each fifty feet wide and fifty feet apart from each other, thus leaving a gap or void between them, so that a crane can hoist a load through the numerous wells or hatches either from the road or from the rail. Having so hoisted a load from either one or the other into the sorting room, the crane, which can move loads in all three dimensions of space, deposits its burden on to the required bay or sorting deck. When a container is thus deposited on the floor of the sorting room, it is opened either at the back or the sides or top, and the contents are removed, and checked against a list in the usual manner. The separate packages of which the load consists are now put on to steel trays which run at each side of the bay, and are shown on the diagram marked R D. These trays move at the will of the man in charge of that particular sorting deck. When a tray in moving from the point R to the point D reaches the point D, a man called the distributor reads the address on the parcels with which the tray is loaded. Supposing he sees that the parcel (or parcels) is directed to Manchester, he knows that the number of the Manchester bay is, say, 123. He would strike the appropriate keys on the instrument before him, and depress his starting-switch. Nothing would happen as a consequence of this, until a disengaged section of this travelling platform reached an exact point. The arrival of this disengaged section at an exact point would complete certain electric circuits energising a pair of roller magnets fixed at the despatching point, and also a similar pair of roller magnets fixed on the conveyor section. These two pairs of rollers would rotate synchronously, that is to say, they would rotate at the same speed. Now the property of these roller magnets is interesting. The effect of magnetising anything is to make it sticky. The stickiness of the magnets in question is something in the nature of a quarter of a ton, but although these magnets stick to the bottom of the tray, and will not let it slip from them, yet they can be easily rotated, and will roll on the under-surface or bottom of the tray quite freely. Thus when these magnets begin to rotate, they drive the tray forward in a given direction and at a uniform acceleration. When the tray, being despatched, has got midway between the despatching point and the moving platform, it is travelling at its highest speed. The despatching magnets release it at this point, and the receiving magnets on the moving platform seize it, and, by continuing their rotation, bring it into a central position on the moving surface of the section. At this moment they come to a halt, they drop downwards, and in so dropping thrust two cone-shaped bolts into the bottom of the tray, thus fixing it to the conveyor. On arriving at the predetermined point, which we have called 123, these roller magnets are again energised. They rise in their bearings, and in so rising they withdraw the bolts, unfastening the

tray from the conveyor, and by a synchronous rotation discharge the tray on to a receiving point, which is also fitted with a pair of similar magnets.

The foregoing would be a very simple operation, but it would not be sufficient for Clearing House purposes. It would be constantly necessary for bales, crates, and parcels to pass from one end of the Clearing House to the other, or from one floor of the Clearing House to the other.

You will note from this plan that the floors of the sorting-rooms are veined by what I have previously called magnetic rivers. Not only could a tray be conveyed from one point to another on the same magnetic river in the way I have just described, but more than this can be done, much more. You will see there are six divisional conveyors or belts, which are numbered one to six and coloured green on the plan; and running inside the wall of the building, all the way round, you will see there is another very big conveyor coloured red; that big conveyor I call the main belt; it links up all the six divisional belts. On the inner side of it you see it runs in parallel contact with the ends of the divisional belts. On its outer edge you will notice it runs in parallel contact with another belt. This other belt is called the dipping belt, coloured purple; perhaps I shall best describe it by calling it a loop belt. There are ten of these belts. They journey from the sorting floor below to the sorting floor above, and down again to the sorting floor below. They are placed all the way round the building, and act as connecting links between the two main belts.

Now a feature of the Clearing House system is, that a bale of goods can be placed on a tray, and the operator having struck the necessary keys on his despatching instrument and depressed his starting-switch, the tray will start on its journey; that journey might involve the following transfers before reaching the predetermined destination. Supposing that the despatch point were at the north end of the Clearing House, and the receiving point were at the south end, *and* on the floor above, the route would be as follows:—

The tray would travel in this direction until it reached the main belt. This main belt goes at double the speed of the divisional belt, and therefore main belt sections are constantly overtaking the divisional belt sections. On a disengaged main belt section coming into correspondence with an engaged divisional belt section, and the controlling apparatus on the divisional section permitting, a transfer of the tray would take place automatically from the divisional belt section to the main belt section. The main belt section would then have possession of the tray, and on coming into contact with the dipping belt section a little further on, the main belt section would re-transfer it to the dipping belt section. The dipping belt section would take it to the floor above, and in the same way as before transfer it to the main belt on the upper floor. The main belt on the upper floor would then carry it to the required divisional belt on that floor, and would deliver it to a disengaged section of that belt. The divisional belt on the upper floor would then carry it to the receiving point, where it would be delivered. The whole of these transfers are automatic, and are performed without any concussion. It will be noted that, together with the transfer of the tray, the original register set by the operator in the first instance is transmitted from one instrument to the other until the final directions are received on the receiving divisional belt. In fact, these instruments practically talk to each other.

I will now return to the less scientific side of the question.

We have postulated that it might be necessary for the clearing house to receive one train per minute at certain hours during the day. This would involve a large intake of goods in the sorting rooms, which would have to be dealt with very expeditiously.

Let us suppose that in a busy hour of the day 1,200 loads of miscellaneous articles need to be hoisted into the sorting rooms and there dealt with. If each load were to weigh two tons, that would amount to 2,400 tons. If all these bales and packages were small, the average weight might be half a hundredweight each. This would be an abnormally small lot, but in such a case the sorting room would be required to sort nearly 100,000 packages in the hour.

We know very well that without machinery it could not be done, but with the introduction of machinery all that is altered.

The first process of distribution is accomplished by the cranes which hoist the containers into the sorting room, each container being placed in its appointed position. These containers have to be opened and their miscellaneous contents distributed all over the two floors, so that each package can reach its appointed place. The items are removed from the containers in which they arrive, are checked in the usual manner against a list, and the

porters place them on any of the adjacent trays.

Let us suppose that in this busy time of the day we employ 2,000 of these porters. I think you will agree that without particularly exerting himself, each porter during the hour could manage to take fifty parcels out of a container and put them on to a tray, and to remove fifty parcels from a tray and put them into a container—that is to say, that each porter would be called upon to handle 100 parcels in an hour—that is to say, each porter has to read an address and move a parcel either by hand or by means of a pneumatic hoist, from a container to a tray, or *vice versâ*, the distance between the tray and the container being three feet or four feet perhaps. Half a minute does not sound a very long time, but I think that if I were to pause in speaking to you for half a minute in search of a word, you will find it a very long time indeed. I am perfectly certain that the time I am here allowing is ample, because it is five times as long as the sorters at the Parcels Post Office, Clerkenwell, take to do the same work, i.e., handle a parcel.

With regard to the rate at which these trays, each carrying one parcel or more, can be distributed, you will see by the plan that there are some 216 distributing points. Supposing the Clearing House to be working at full shift, and supposing that each of these men were to despatch about five trays a minute, you will see that our speed of sorting would be about 1,000 trays a minute, and, as I said before, these trays would carry one, two, or more parcels apiece.

I think I have now indicated the speed capacity of the Clearing House, and when we come to compare a performance of this description with the system at present in vogue, I think it will be agreed that the new plan is an improvement.

By the hand and hand-truck method, even granting the floor space I have specified, the work done by 2,000 men rushing about the Clearing House with hand trucks is a spectacle of chaos, before which one's imagination absolutely quails. Let these men work as hard as they like, it would be difficult for a man to make more than five or six hand-truck journeys in the course of an hour; but with only 10 per cent. of these men, each standing at the distributor's desk and striking the keys and depressing the switch, I see no difficulty in their performing this duty in one minute or less. We all of us know the condition of a railway platform on the arrival of a heavy train from the Continent, and the scrimmage which takes place in order to get our luggage on to our cab. That gives a very good idea of the present system of sorting goods at a goods station by hand. I think it is best described by the word "scrimmage."

Scientifically speaking, the difficulty lies in the conflicting lines of traffic on the goods station platform. In the Clearing House there are no conflicting lines of traffic; the platforms are only four feet wide as against the fifty feet wide platform of the goods station, and yet, though less than one-twelfth of the width of the latter, the Clearing House moving platform can do twenty times the amount of work; but whether the speed of the Clearing House is ten times as great, is not of immediate moment. The question of importance is whether machinery is better for our purpose than hand and hand-truck methods, and, if so, what are the reasons for opposing its adoption.

We will now turn our attention to the question of cartage of goods by road to and from the clearing house, and we will see how rapid loading and unloading of vehicles affects the question.

Under existing circumstances, a carrier's van, or railway van, will usually spend eight hours a day out of an available twelve to sixteen in loading and unloading at the depot. If this eight hours spent in loading and unloading can be reduced to something less than half an hour, it is clear that this van would have seven and a half hours more time available for doing work. This reform alone would admit of one van doing the work of three, but there are many other economies to be effected by the adoption of the Clearing House system.

Let us now consider what would be the number of vans requisite to do a day's work to and from the Clearing House in the administrative county of London.

To begin with, there are 634,110 houses (occupied or unoccupied) in this area. We will suppose it to be necessary to visit about one house in ten every day—that is to say, we will suppose that a day's work will consist of visiting 63,000 houses of all sorts and kinds; some of these houses will be private, and others will be business houses. Some houses it would be requisite to visit many times, and others only once, either to collect or deliver goods. It must be borne in mind that we are now considering slow-going van traffic, and in this category we of course do not include the rapid cart of the butcher and the baker and other local tradesmen.

Let us suppose that in dealing with the 63,000 houses we propose to visit, either to collect or deliver goods, we make the following calls :—

Number of Houses.	Number of Times Visited.	Total Visits.
20,000	1	20,000
15,000	2	30,000
10,000	3	30,000
5,000	4	20,000
4,000	5	20,000
3,000	6	18,000
3,000	7	21,000
2,000	10	20,000
1,000	20	20,000
20	50	1,000
63,020		200,000

We will now consider what the visiting capacity of a Clearing House car might be in, let us say, twelve hours.

Let us assume that each car makes 100 visits a day, each visit occupying five minutes. This would give us 500 minutes, or eight hours and twenty minutes out of the available twelve. This would allow us about three hours and twenty minutes on the road, and leave a total of twenty minutes spent in the Clearing House loading and unloading. With a running time of three hours odd at eight miles an hour, each car could perform an average of four journeys to and from the Clearing House, each journey being an average of three miles out and three miles in. In order to call on the 63,000 houses necessary, and make the requisite 200,000 visits during the day, we should, of course, require 2,000 cars to do the work.

I do not say that this estimate is correct, or approximately correct, as regards actual requirements ; I merely say that supposing the work to be what I have indicated, it could be done by 2,000 cars. The actual number of slow-going vans now employed on the London streets, either privately owned, or owned by the railway companies or the carriers, is not known, but the Midland Railway have admitted that they have 1,000 of these vehicles in use on the London streets, and if this may be taken as any criterion of the number of road wagons employed by the other railway companies in London, we must needs multiply this figure by at least ten. This would give us a total of 10,000 railway wagons in use on the streets of London, and as a matter of fact we have almost an equal number of carriers' vans, as will be seen by reference to Appendix C.

So long as the railway managers withhold the necessary information, so long, of course, we are deprived of the advantage of investigating the subject in the light of exact figures. Why railway managers object to investigation, I do do not know. I should be glad to know. If railway managers will tell us the exact amount of collection and delivery work that has to be done, together with full details, we shall be able to make a closer estimate. It must be remembered that railway arrangements, as at present devised, tend to force all the work into a few hours, whereas Clearing House arrangements, as proved in practice in the Bankers' Clearing House, tend to spread it over the whole day.

The question whether the traffic of London streets would be perceptibly relieved if this work of collèction and delivery were done by 2,000 cars, or even 4,000 cars, is best answered by reminding you that the mileage of London streets is, according to the London County Council published statistics, 2,192 miles. Therefore, if 4,000 cars, double the number I have postulated, were distributed over these streets, there would be one car to every half mile of streets. On the other hand, under existing conditions, on the basis of the Midland Railway admission, we must assume that the number of railway vans only on the streets of London is, in round figures, 10,000. I simply use this estimate as a basis of calculation, and I leave the railway managers, who have access to exact sources of information, to correct me. My argument, however, will not be shaken by any possible amendment, as will be seen. Certain special counts of vehicles have been made by the expert advisers of the New Transport Company, Limited, and the results will be found in Appendix C., previously mentioned. Reference to this Appendix shows that nearly half the street traffic of London consists of goods vehicles. The classified enumeration shows that railway vans form more than a quarter of the total of goods vehicles in use, and carriers' vans over one-sixth. If the number of railway vans is 10,000, more or less, the total trade vehicles must be put at 40,000, more or less.

I have shown you what an organised service of 2,000 cars might be reasonably expected to do, and if we go so far as to double that number, that would only be 10 per cent. of the vehicles now blocking the streets of London to the unnecessary and avoidable detriment of everybody using the thoroughfares. This is my answer to the question that has been put to me: "How would the Clearing House relieve the congested condition of the streets of London?"

I shall be very grateful to any member of the audience who will be so kind as to amend any figure I have advanced.

APPENDIX A.

DIGEST OF ROUTES.

FROM THE VARIOUS RAILWAY SYSTEMS TO THE PROPOSED GOODS CLEARING HOUSE.

Prepared for the New Transport Company, Limited, Bath House, Holborn Viaduct, E.C.

By VERNON R. M. GATTIE.

Introductory Note.

The routes here given are classified under three headings —

Main Routes,
Subsidiary Routes,
and Emergency Routes.

The main routes are those routes which a train would naturally take—distinguished by directness and continuance over the same system, where possible. It will thus be found that each system has one, or at most two main routes to the Clearing House.

The subsidiary routes are those routes which might with advantage be employed in the event of the main route becoming unduly congested at any period, or in the event of a temporary stoppage of the main route. In most cases, the distance over the subsidiary route is not much longer than that over the main route.

The emergency routes are those routes which, by reason of their devious nature or unfavourable road or gradients, would only be employed in the event of an accident on the main and subsidiary routes.

In some cases, no subsidiary routes are given. This is where there is no route beyond the main route which could with any advantage be mployed except in the event of accident.

Where no emergency routes are given, it is because they are too devious to be within the range of practical utility.

GREAT NORTHERN RAILWAY.

All lines run to Finsbury Park.

Main Route.

Route 1.—*Via* Finsbury Park and King's Cross.

Subsidiary Route.

Route 2.—*Via* Finsbury Park, to N. London Railway, Canonbury, Dalston Junction and Broad Street.

MIDLAND RAILWAY.

All lines run to Hendon.

Main Route.

Route 1.—*Via* West Hampstead, Kentish Town, and St. Pancras.

Subsidiary Route.

Route 2.—To Metropolitan Railway, Finchley Road, Baker Street, and King's Cross. (This route only by shunting.)

Emergency Routes.

Route 3.—*Via* West Hampstead, to Tottenham and Hampstead Junction Railway, South Tottenham, to G.E. Railway, Clapton Junction, Hackney Downs, and Bishopsgate.

Route 4.—To N. & S.W. Junction Joint Railway, Acton Wells Junction, South Acton, to L. & S.W. Railway, Clapham Junction, to S.E. & C. Railway, Loughborough Junction, and Snow Hill.

Route 5.—To N. & S.W. Junction Joint Railway, Acton Wells Junction, South Acton, to L. & S.W. Railway, Grove Road, to Hammersmith & City Joint Railway, Westbourne Park, to G.W. Railway, Bishop's Road, to Metropolitan Railway, Baker Street, and King's Cross.

LONDON AND NORTH-WESTERN RAILWAY.

All lines run to Willesden Junction.

Main Route.

Route 1.—To N. London Railway, Camden Town, to Midland Railway, St. Pancras—

(*a*) *Via* Gospel Oak and Kentish Town.
(*b*) *Via* Chalk Farm.

Subsidiary Route.

Route 2.—To N. London Railway, Camden Town, Dalston Junction and Broad Street—

(*a*) *Via* Gospel Oak and Kentish Town.
(*b*) *Via* Chalk Farm.

Emergency Route.

Route 3.—To West London Joint Railway, Addison Road, to West London Extension Joint Railway, West Brompton, to S.E. & C. Railway, Loughborough Junction, and Snow Hill.

GREAT CENTRAL RAILWAY.

All lines run to Neasden.

Main Route.

Route 1.—To Metropolitan Railway, Finchley Road, Baker Street, and King's Cross.

Emergency Routes.

Route 2.—To Midland Railway, Acton Wells Junction, to N. & S.W. Junction Joint Railway, South Acton, to L. & S.W. Railway, Clapham Junction, to S.E. & C. Railway, Loughborough Junction, and Snow Hill.

Route 3.—To Midland Railway, Acton Wells Junction, to N. & S.W. Junction Joint Railway, South Acton, to L. & S.W. Railway, Grove Road, to Hammersmith and City Joint Railway, Westbourne Park, to G.W. Railway, Bishop's Road, to Metropolitan Railway, Baker Street, and King's Cross.

NOTE.—The line from High Wycombe can utilise Routes 2 and 3 above, and also all routes open to trains from the Great Western Railway.

GREAT WESTERN RAILWAY.

The two lines from Reading and from High Wycombe join by way of Greenford and Hanwell, so that all routes are interchangeable.

Main Route.

Route 1.—*Via* Ealing, Bishop's Road, to Metropolitan Railway, Baker Street, and King's Cross.

Subsidiary Route.

Route 2.—To N. London Railway, Camden Town, to Midland Railway, St. Pancras—

(*a*) *Via* Ealing, Acton Wells Junction, to N. & S.W. Junction Joint Railway to L. & N. W. Railway, Willesden Junction, Gospel Oak, and Kentish Town.

(*b*) *Via* Ealing, Acton Wells Junction to N. & S.W. Junction Joint Railway Willesden Junction, to L. & N.W. Railway, Chalk Farm.

Emergency Routes.

Route 3.—To N. London Railway, Camden Town, Dalston Junction, and Broad Street—

(*a*) As above Route 2 (*a*).

(*b*) As above, Route 2 (*b*).

Route 4.—*Via* Ealing, to West London Joint Railway, Addison Road, to West London Extension Joint Railway, West Brompton, to S.E. & C. Railway, Loughborough Junction, and Snow Hill.

NOTE.—Trains coming from High Wycombe can only utilise Routes 2 and 3 by way of Greenford and Ealing.

Trains from High Wycombe can also utilise Routes 2 and 3 of G.C. Railway.

LONDON AND SOUTH-WESTERN RAILWAY.

I. Main line from Woking or Guildford and line from Epsom. All trains go through Wimbledon.

II. Line from Staines *via* Feltham.

The branch line from Shepperton can join either route by way of Coombe and Malden or Twickenham.

I. Main line *via* Wimbledon.

Main Route.

Route 1.—To S.E. & C. Railway, Loughborough Junction, and Snow Hill—

(*a*) *Via* Clapham Junction.

(*b*) To L.B. & S.C. and L. & S.W. Joint Railway, Streatham, to L.B. & S.C. Railway, Tulse Hill.

Emergency Routes.

Route 2.—To L.B. & S.C. and L. & S.W. Joint Railway, Streatham, to L.B. & S.C. Railway, Tulse Hill, Peckham Rye, Old Kent Road, to E. London Joint Railway, Deptford Road, and Bishopsgate.

Route 3.—*Via* Clapham Junction, to W. London Extension Joint Railway, West Brompton, to W. London Railway, Addison Road, to Hammersmith and City Joint Railway, Westbourne Park, to G.W. Railway, Bishop's Road, to Metropolitan Railway, Baker Street, and King's Cross.

II. Line from Staines.

Main Route.

Route 1.—To S.E. & C. Railway, Loughborough Junction, and Snow Hill—

(*a*) *Via* Brentford, Kew Bridge, Barnes, and Clapham Junction.

(*b*) *Via* Twickenham, Richmond, and Clapham Junction.

Subsidiary Routes.

Route 2.—To N. London Railway, Camden Town, to Midland Railway, St. Pancras—

(*a*) *Via* Brentford, to N. & S.W. Junction Joint Railway, Kew Bridge, Acton Wells Junction, to L. & N.W. Railway, Willesden Junction, Gospel Oak, and Kentish Town.

(*b*) *Via* Brentford, to N. & S.W. Junction Joint Railway, Kew Bridge, Acton Wells Junction, Willesden Junction to L. & N.W. Railway, Chalk Farm.

Route 3.—*Via* Brentford, Kew Bridge, Grove Road, to Hammersmith and City Joint Railway, Westbourne Park, to G.W. Railway, Bishop's Road, to Metropolitan Railway, Baker Street, and King's Cross.

Emergency Routes.

Route 4.—To N. London Railway, Camden Town, Dalston Junction, and Broad Street—

(*a*) *Via* Brentford, to N. & S.W. Junction Joint Railway, Kew Bridge, Acton Wells Junction, to L. & N.W. Railway Willesden Junction, Gospel Oak, and Kentish Town.

(*b*) *Via* Brentford, to N. & S.W. Junction Joint Railway, Kew Bridge, Acton Wells Junction, Willesden Junction, to L. & N.W. Railway, Chalk Farm.

Route 5.—*Via* Brentford, Kew Bridge, Shepherd's Bush, to W. London Junction Railway, Addison Road, to West London Extension Junction Railway, West Brompton, to S.E. & C. Railway, Loughborough Junction, and Snow Hill.

Route 6.—*Via* Twickenham, Richmond, Clapham Junction, to W. London Extension Joint Railway, West Brompton, to W. London Railway, Addison Road, to Hammersmith and City Joint Railway, Westbourne Park, to G. W. Railway, Bishop's Road, to Metropolitan Railway, Baker Street, and King's Cross.

NOTE.—Routes 2 and 4 can also be followed by way of Richmond.

LONDON, BRIGHTON AND SOUTH COAST RAILWAY.

I. Trains from Redhill which proceed—

(*a*) *Via* Norwood Junction.

or (*b*) *Via* Selhurst.

II. Trains from Epsom and Sutton which proceed—

(*a*) *Via* Mitcham Junction.

(*b*) *Via* Norwood Junction.

(*c*) *Via* Selhurst.

I. Trains from Redhill.

Main Routes.

Route 1.—*Via* Norwood Junction, New Cross, to S.E. & C. Railway, London Bridge, and Snow Hill.

Route 2.—*Via* Tulse Hill, to S.E. & C. Railway, Herne Hill, Loughborough Junction, Snow Hill—

(*a*) *Via* Norwood Junction and Crystal Palace.

(*b*) *Via* Selhurst and Streatham.

Emergency Routes.

Route 3.—*Via* Norwood Junction, New Cross, to E. London Railway, Deptford Road, and Bishopsgate.

Route 4.—*Via* Tulse Hill, Peckham Rye, Old Kent Road, to E. London Railway, Deptford Road and Bishopsgate—

(*a*) *Via* Norwood Junction and Crystal Palace.

(*b*) *Via* Selhurst and Streatham.

II. Trains from Epsom and Sutton.

Main Routes.

Route 1.—*Via* Norwood Junction, New Cross, to S.E. & C. Railway, London Bridge, and Snow Hill.

Route 2.—*Via* Tulse Hill, to S.E. & C. Railway, Herne Hill, Loughborough Junction, and Snow Hill—

(*a*) *Via* Mitcham Junction and Streatham.

(*b*) *Via* Norwood Junction and Crystal Palace.

(*c*) *Via* Selhurst and Streatham.

Subsidiary Route.

Route 3.—*Via* Clapham Junction, to S.E. & C. Railway, Loughborough Junction, and Snow Hill—

(*a*) *Via* Mitcham Junction and Wimbledon.

(*b*) *Via* Mitcham Junction and Streatham.

Emergency Routes.

Route 4.—*Via* Norwood Junction, New Cross, to S.E. & C. Railway, London Bridge and Snow Hill.

Route 5.—*Via* Tulse Hill, Peckham Rye, Old Kent Road, to E. London Railway, Deptford Road, and Bishopsgate—

(*a*) *Via* Mitcham Junction and Streatham.

(*b*) *Via* Norwood Junction and Crystal Palace.

(*c*) *Via* Selhurst and Streatham.

NOTE.—The line from Oxted, run conjointly with the S.E. & C. Railway, can employ any of the routes from Redhill, and also routes over the S.E. & C. Railway, for which see thereunder.

SOUTH-EASTERN AND CHATHAM RAILWAY.

I. Routes *via* New Cross.

II. Routes *via* Bromley.

I. Routes *via* New Cross.

Main Route.

Route 1.—*Via* New Cross, London Bridge, and Snow Hill.

Emergency Route.

Route 2.—*Via* New Cross, to E. London Joint Railway, Deptford Road, and Bishopsgate.

NOTE.—The various lines from Chatham which can employ either of these routes are—

1. *Via* Chislehurst.
2. *Via* Hither Green.
3. *Via* Charlton Junction, Blackheath, and Lewisham.

The line from Dartford proceeds *via* Lewisham.

II. Routes *via* Bromley.

Main Route.

Route 1.—*Via* Loughborough Junction and Snow Hill—

(*a*) *Via* Bromley, Beckenham, and Herne Hill.

(*b*) *Via* Bromley, Beckenham, to L.B. & S.C. Railway, Crystal Palace, Tulse Hill, to S.E. & C. Railway, Herne Hill.

(*c*) *Via* Bromley, Nunhead, to L.B. & S.C. Railway, Peckham Rye, to S.E. & C. Railway.

Emergency Route.

Route 2.—*Via* Bromley, Beckenham, to L.B. & S.C. Railway, Crystal Palace, Tulse Hill, Peckham Rye, Old Kent Road, to E. London Joint Railway, Deptford Road, and Bishopsgate.

NOTE.—The only line from Chatham which can employ either of these routes is that *via* Chislehurst.

There are also branch lines from Crystal Palace and Greenwich Park which have separate routes. All other branch lines join the main line.

From Crystal Palace and from Greenwich Park.

Route 1.—*Via* Nunhead, to L.B. & S.C. Railway, Peckham Rye, to S.E. & C. Railway, Loughborough Junction, and Snow Hill.

Line from Oxted run conjointly with L.B. & S.C. Railway. For routes over the L.B. & S.C. line see thereunder.

Routes over S.E. & C. Railway—

Main Route.

Route 1.—*Via* Beckenham, New Cross, London Bridge, and Snow Hill.

Emergency Route.

Route 2.—*Via* Beckenham, New Cross, to E. London Joint Railway, Deptford Road, and Bishopsgate.

NOTE.—The above two routes are those employable by trains from Addiscombe Road and from Hayes.

GREAT EASTERN RAILWAY.

I. Main line from Cambridge.

All trains run through Tottenham.

Main Routes.

Route 1.—*Via* Bethnal Green and Bishopsgate—
- (*a*) *Via* Clapton Junction and Hackney Downs.
- (*b*) *Via* Loughton Junction and Stratford.
- (*c*) *Via* Loughton Junction and Channelsea Junction.

Route 2.—*Via* Stepney and Goodman's Yard—
- (*a*) *Via* Loughton Juncton and Stratford.
- (*b*) *Via* Loughton Junction and Channelsea Junction.

Subsidiary Routes.

Route 3.—*Via* Loughton Junction, Victoria Park, to N. London Railway, Dalston Junction, and Broad Street.

Route 4.—To Tottenham and Hampstead Junction Joint Railway, South Tottenham, Highgate Road, to Midland Railway, Kentish Town and St. Pancras.

II. Line from Chingford.

All the above routes are available.

III. Line from Ongar.

Routes 1–3 above are available by way of Loughton Junction.

IV.—Lines from Enfield and Cheshunt.

(1) All trains can proceed *via* Angel Road and Tottenham, and thus employ any of the routes above.

(2) All trains can proceed *via* Seven Sisters.

Main Routes.

Route 1.—*Via* Bethnal Green and Bishopsgate—
- (*a*) *Via* Seven Sisters and Hackney Downs.
- (*b*) *Via* Seven Sisters, Clapton Junction, and Hackney Downs.
- (*c*) *Via* Seven Sisters, Loughton Junction, and Stratford.
- (*d*) *Via* Seven Sisters, Loughton Junction, and Channelsea Junction.

Route 2.—*Via* Stepney and Goodman's Yard.
- (*a*) *Via* Seven Sisters, Loughton Junction, and Stratford.
- (*b*) *Via* Seven Sisters, Loughton Junction, and Channelsea Junction.

Subsidiary Route.

Route 3.—*Via* Seven Sisters, Loughton Junction Victoria Park, to N. London Railway, Dalston Junction, and Broad Street.

V. Line from Wood Green.

All trains can employ any of the above routes except Route 4 above.

VI. Line from Colchester.

All trains run through Stratford.

Main Routes.

Route 1.—*Via* Stratford, Bethnal Green, and Bishopsgate.

Route 2.—*Via* Stratford, Stepney, and Goodman's Yard.

Subsidiary Route.

Route 3.—*Via* Stratford, Victoria Park, to N. London Railway, Dalston Junction, and Broad Street.

VII. Line from Beckton, North Woolwich, and Gallions (Port of London Authority).

Main Routes.

Route 1.—*Via* Stratford Market, Bethnal Green, and Bishopsgate.

Route 2.—*Via* Stepney and Goodman's Yard—
- (*a*) *Via* Stratford Market.
- (*b*) *Via* London, Tilbury, and Southend Railway, Bromley, to G.E. Railway.

Subsidiary Route.

Route 3.—To N. London Railway, Dalston Junction, and Broad Street—
- (*a*) *Via* Stratford and Victoria Park.
- (*b*) To London, Tilbury, and Southend Railway, Bromley.

VIII. Line from North Greenwich and Blackwall.

Main Route.

Route 1.—*Via* Stepney and Goodman's Yard.

Subsidiary Route.

Route 2.—*Via* Burdett Road, to N. London Railway, Dalston Junction, and Broad Street.

London, Tilbury and Southend Railway.

All lines run to Barking.

Main Routes.

Route 1.—*Via* East Ham, Bromley, to G.E. Railway. Stepney, and Goodman's Yard.

Route 2.—*Via* Forest Gate, to G.E. Railway, Stratford, and Bishopsgate.

Subsidiary Routes.

Route 3.—*Via* East Ham, Bromley, to N. London Railway, Dalston Junction, and Broad Street.

Route 4.—*Via* Forest Gate, to G.E. Railway, Stratford, Victoria Park, to N. London Railway, Dalston Junction, and Broad Street.

Emergency Route.

Route 5.—*Via* Forest Gate, to Tottenham and Forest Gate Joint Railway, South Tottenham, to Tottenham and Hampstead Junction Joint Railway, Highgate Road, to Midland Railway, Kentish Town, and St. Pancras.

North London Railway.

From Poplar.

Main Route.

Route 1.—*Via* Dalston Junction to Broad Street.

APPENDIX B.

A List of London Goods Stations.

2.	G.C.	Neasden.
	M.	Dudding Hill.
3.	G.N.	Highgate.
4.	G.N.	Caledonian Road.
	G.N.	Clarence Yard.
	G.N.	Ashburton Grove.
	G.N.	Highbury Vale.
	N.W.	Highbury.
	N.W.	Kingsland.
	N.W.	Maiden Lane.
	G.E.	Tufnell Park.
5.	G.E.	Hackney Downs.
	G.E.	Clapton.
	G.E.	Stratford.
	G.N.	Hackney Wick.
6.	G.E.	Forest Gate.
7.	N. & S.W. Junction	Kew Bridge.
8.	N.W.	Willesden.
	N.W.	Mitre Bridge.
	M.	Harlesden.
	G.W.	Old Oak Common.
	G.W.	Uxbridge Road.
	N.W.	Warwick Road.
9.	M.	W. Kensington.
	G.W.	Warwick Road.
	G.W.	Paddington.
	G.W.	Mileage Yard.
	G.C.	Marylebone.
	N.W.	Brompton and Fulham.
	W.L. Extension	Lillie Bridge.
	N.W.	Camden.
	N.W.	Kilburn and Maida Vale.
10.	M.	St. Pancras.
	M.	Somers Town.
	G.N.	King's Cross.
	G.N.	Mint Street.
	M.	Mint Street.
	N.W.	Shoreditch.
	N.W.	Worship Street.
	N.W.	Broad Street.
	N.W.	Haydon Square.
	G.N.	Farringdon Street.
	M.	Whitecross Street.
	G.E.	Bishopsgate.
	G.E.	Spitalfields.
	G.E.	Goodman's Yard.
	S.E. & C.	Blackfriars.
	S.E. & C.	Gravel Lane Depot.
	S.E. & C.	Bricklayer's Arms.
	L.B.	Willow Walk.
	S.W.	Nine Elms.
	L.T. & S.	Commercial Road.
11.	G.E.	Carpenter's Road.
	G.E.	Devonshire Street.
	G.E.	Bow Road.
	M.	Bow Depot.
	N.W.	Bow Depot.
	N.W.	Old Ford.
	N.W.	Devons Road.
12.	G.E.	Stratford Market.
	G.E.	Plaistow and West Ham.
	N.W.	Upton Park Depot.
	N.W.	Canning Town.
15.	S.E. & C.	Stewart's Lane.
	L.B.	Battersea.
	S.W.	Clapham.
16.	N.W.	Knight's Hill.
	S.E. & C.	Camberwell.
17.	G.E.	New Cross.
	N.W.	Brockley Lane Depot.
	N.W.	Peckham Rye.
	M.	Peckham Rye.

The figures refer to the eighteen squares forming the central portion of the official Railway Clearing House Map of London and Environs.

Key.

		1	2	3	4	5	6	
		7	8	9	10	11	12	
		13	14	15	16	17	18	

N.B.—This list of seventy-two goods stations and goods yards does not include coal, cattle, or mere sidings, nor does it include several hundred receiving depots.

APPENDIX C.

ENUMERATION OF TRADE VEHICLES IN GRAY'S INN ROAD (BETWEEN HOLBORN AND CLERKENWELL ROAD) PROCEEDING BOTH WAYS BETWEEN THE HOURS OF 3 P.M. AND 7 P.M. ON FRIDAY, MARCH 17TH, 1911 (WEATHER DULL).

	3 p.m. to 4 p.m.			4 p.m. to 5 p.m.			5 p.m. to 6 p.m.			6 p.m. to 7 p.m.			Total.		
	1 horse.	2 horse.	Total.	1 horse.	2 horse.	Total.	1 horse.	2 horse.	Total.	1 horse.	2 horse.	Total.	1 horse.	2 horse.	Total.
Railway Vans	46	8	54	51	10	61	41	13	54	67	14	81	213	45	258
Selected Carriers	11	5	16	7	3	10	5	3	8	8	4	12	31	15	46
Other Carriers	27	8	35	27	6	33	29	3	32	10	1	11	93	18	111
Total Carriers	84	21	105	85	19	104	75	19	94	93	19	112	337	78	415
Large Shops	11	1	12	9	1	10	10	—	10	8	—	8	88	2	40
Other Shops	1	1	2	6	2	8	4	1	5	4	—	4	15	4	19
Manufacturers	16	5	21	20	11	31	18	12	30	10	4	10	64	32	96
Other Trade Vehicles—															
Provisions	5	1	6	11	3	14	4	2	6	3	—	3	23	6	29
Coal	19	1	20	21	2	23	35	1	36	30	—	30	105	4	109
Building Trade	8	2	10	5	1	6	5	—	5	2	—	2	20	3	27
Newspapers	12	—	12	11	—	11	6	—	6	6	—	6	35	—	35
Miscellaneous	29	5	34	31	7	38	29	12	41	27	9	36	116	33	149
Total, other than Carriers	101	16	117	114	27	141	111	28	139	90	13	103	416	84	500
Total Trade Vehicles	185	37	222	199	46	245	186	47	233	183	32	215	753	162	915
Royal Mail and other Government Vehicles	8	3	11	8	5	13	11	2	13	6	5	11	33	15	48
Municipal	1	—	1	—	—	—	4	—	4	2	—	2	7	—	7
Grand Total	194	40	234	207	51	258	201	49	250	191	37	228	793	177	970

In addition to above there were 11 Motor Vehicles, classified as Selected Carriers 2, Newspapers 4, and Miscellaneous 5. Total . . 11

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ENUMERATION OF TRADE VEHICLES IN GRAY'S INN ROAD (BETWEEN HOLBORN AND CLERKENWELL ROAD) PROCEEDING FROM HOLBORN BETWEEN THE HOURS OF 3 P.M. AND 7 P.M. ON FRIDAY, MARCH 17TH, 1911 (WEATHER DULL).

	3 p.m. to 4 p.m.			4 p.m. to 5 p.m.			5 p.m. to 6 p.m.			6 p.m. to 7 p.m.			Total.		
	1 horse.	2 horse.	Total.	1 horse.	2 horse.	Total.	1 horse.	2 horse.	Total.	1 horse.	2 horse.	Total.	1 horse.	2 horse.	Total.
Railway Vans	15	5	20	17	3	20	24	5	29	59	12	71	115	25	140
Selected Carriers	8	4	12	3	2	5	3	1	4	5	2	7	19	9	28
Other Carriers	14	4	18	13	3	16	13	2	15	6	—	6	46	9	55
Total Carriers	37	13	50	33	8	41	40	8	48	70	14	84	180	43	223
Large Shops	7	1	8	6	1	7	6	—	6	3	—	3	22	2	24
Other Shops	—	—	—	1	—	1	1	—	1	2	—	2	4	—	4
Manufacturers	5	—	5	5	3	8	10	5	15	7	—	7	27	8	35
Other Trade Vehicles—															
Provisions	5	1	6	11	3	14	4	2	6	3	—	3	23	6	29
Coal	8	—	8	9	2	11	7	1	8	11	—	11	35	3	38
Building Trades	8	2	10	4	—	4	3	—	3	—	—	—	15	2	17
Newspapers	8	—	8	5	—	5	4	—	4	4	—	4	21	—	21
Miscellaneous	20	5	25	21	5	26	16	8	24	19	5	24	76	23	99
Total other than Carriers	61	9	70	62	14	76	51	16	67	49	5	54	223	44	267
Total Trade Vehicles	98	22	120	95	22	117	91	24	115	119	19	138	403	87	490
Royal Mail and Government	5	2	7	5	4	9	7	1	8	3	1	4	20	8	28
Municipal	1	—	1	—	—	—	—	—	—	—	—	—	1	—	1
Grand Total	104	24	128	100	26	126	98	25	123	122	20	142	424	95	519

In addition to above there were 10 Motor Vehicles, classified as Selected Carriers 1, Newspapers 4, and Miscellaneous 5.

ENUMERATION OF TRADE VEHICLES IN GRAY'S INN ROAD (BETWEEN HOLBORN AND CLERKENWELL ROAD) PROCEEDING TOWARDS HOLBORN BETWEEN THE HOURS OF 3 P.M. AND 7 P.M. ON FRIDAY, MARCH 17TH, 1911 (WEATHER DULL).

	3 p.m. to 4 p.m.			4 p.m. to 5 p.m.			5 p.m. to 6 p.m.			6 p.m. to 7 p.m.			Totals.		
	1 horse.	2 horse.	Total.	1 horse.	2 horse.	Total.	1 horse.	2 horse.	Total.	1 horse.	2 horse.	Total.	1 horse.	2 horse.	Total.
Railway Vans	31	3	34	34	7	41	17	8	25	16	2	18	98	20	118
Selected Carriers	3	1	4	4	1	5	2	2	4	3	2	5	12	6	18
Other Carriers	13	4	17	14	3	17	16	1	17	4	1	5	47	9	56
Total Carriers	47	8	55	52	11	63	35	11	46	23	5	28	157	35	192
Large Shops	4	—	4	3	—	3	4	—	4	5	—	5	16	—	16
Other Shops	1	1	2	5	2	7	3	1	4	2	—	2	11	4	15
Manufacturers	11	5	16	15	8	23	8	7	15	3	4	7	37	24	61
Other Trade Vehicles—															
Provisions	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Coal	11	1	12	12	—	12	28	—	28	19	—	19	70	1	71
Building Trade	—	—	—	1	1	2	2	—	2	2	—	2	5	1	6
Newspapers	4	—	4	6	—	6	2	—	2	2	—	2	14	—	14
Miscellaneous	9	—	9	10	2	12	13	4	17	8	4	12	40	10	50
Total other than Carriers	40	7	47	52	13	65	60	12	72	41	8	49	193	40	233
Total Trade Vehicles	87	15	102	104	24	128	95	23	118	64	13	77	350	75	425
Royal Mail and Government	3	1	4	3	1	4	4	1	5	3	4	7	13	7	20
Municipal	—	—	—	—	—	—	4	—	4	2	—	2	6	—	6
Grand Total	90	16	106	107	25	132	103	24	127	69	17	86	369	82	451

In addition to above there was one Motor Vehicle (Selected Carrier).

Traffic at Certain Important Points in 12 Hours, 8 a.m. to 8 p.m.

	Total goods vehicles.	Number of vehicles of "selected carriers"* included in foregoing column.	Total vehicles (goods and passenger, but excluding barrows and cycles).
At Uxbridge Road Station	4,188	136	5,815
" the Marble Arch	6,247	876	19,611
" Oxford Circus	5,375	1,040	21,324
" Tottenham Court Road (South end)	6,161	1,175	17,901
" the General Post Office	9,321	2,389	16,355
" the Bank	8,592	1,451	24,420
" junction of Cornhill and Gracechurch Street	4,809	871	9,510
" Aldgate Station†	3,715	482	5,126
" Whitechapel High Street (Gardiner's Corner)	11,571	1,179	15,180
At Hammersmith Broadway	4,439	190	7,834
" the junction of Knightsbridge and Sloane Street	5,182	438	19,361
" Hyde Park Corner	7,963	714	26,762
" the junction of Piccadilly and St. James's Street	4,212	386	18,504
" Piccadilly Circus	5,715	859	25,938
" Charing Cross	6,323	637	25,826
" the junction of the Strand and Wellington Street	6,818	Not separately enumerated	17,830
" Ludgate Circus	12,139	2,269	19,790
" Mansion House Station	7,620	1,457	18,210
At Elephant and Castle	6,326	607	14,343

* "Selected carriers" include all railway companies' vans and all those of the following public carriers, viz., The Atlas Express Company, Messrs. Chaplin & Co., the Globe Parcel Express, Messrs. Sutton & Co., Messrs. Thompson, McKay & Co., the London Parcels Delivery Company, Messrs. Carter, Paterson & Co., and Messrs. Pickford & Co.

† These figures relate to Aldgate at junction of Fenchurch Street and Leadenhall Street.

APPENDIX D.

Extract from the Report of the "Railway Times" on Sir Alexander's Henderson Speech at the Half-yearly Meeting of the Great Central Railway, held on February 11th, 1903.

Speaking of railway difficulties Sir Alexander Henderson said :—

"Some of those difficulties were of their own making, and the keen competition—he might almost say the scramble for every ounce of traffic—was to be regretted, but it was hardly likely to be altered until the companies put all their horses together.

"That such a combination would result in great benefits to railway shareholders and to the public, he had not the slightest doubt.

"The economies that could be effected by such a combination were enormous. Taking only the six companies carrying between Manchester and London, the total of their expenditure on collection and delivery of merchandise alone must

come to something like £2,500,000 per annum, and it would no doubt be possible, if some pooling arrangement were entered into, to save a considerable part of that heavy item. That only represented one direction in which economies might be effected. It might be urged that a combination of the railways might be to the disadvantage of the traders and the public, but he was convinced that the interests of the public and the traders could be amply protected and that benefits would accrue from it to the public to an extent quite equal to those that would be received by railway proprietors."

DISCUSSION.

The Chairman, in opening the discussion, said the applause with which the paper had been received intimated how much it had been appreciated. When one's attention had been called to the subject, one realised how the traffic was very much blocked by a large number of goods vans—in nearly all cases empty — getting into each other's way, and stopping outside warehouses. The same thing could be noticed in travelling on a railway. When a large town was being approached a wilderness of shunting yards was passed through, where trucks were, as Mr. Gattie so picturesquely put it, being banged about in a complicated way. It would be realised that the railway companies had to face a very difficult problem when they tried to do shunting and sorting on one plane, that was to say, in one dimension and with only an endways movement. That was obviously a very bad system. Mr. Gattie had referred to the human race as being "creatures of habit." He thought Mr. Gattie might have used a stronger term and said "savages." People had the savage instinct very strongly, especially in a civilised country, and when anything new was proposed in the way of improvement that savage instinct was seen to its best advantage. A person did not, of course, oppose his own new thing, but he opposed everybody else's. Mr. Gattie very boldly faced the big end of the subject, and he was quite right in so doing. By beginning at the big end he had shown how big the problem he was tackling really was. One difficulty which had at the present time to be faced in London was the making of new streets for the accommodation of the traffic, but if Mr. Gattie was right, his scheme would obviate that difficulty, thereby saving an enormous amount of money, probably enough to provide for the proposed new Clearing House.

Mr. H. E. Roper said the author had given an instance of a truck going from Bristol to Brighton, and when it got to Old Oak having to be taken off the Great Western train, put into a siding, then taken by a Great Western engine to another yard, where it was again marshalled into a siding till the Brighton train started. He assumed the whole of the goods in that wagon were for the one destination, namely, Brighton, so he did not quite follow what the object was in taking them out of one truck and putting them into another.

Mr. C. Urquhart Fisher said Mr. Gattie seemed to have been born before his proper time. He thought a great drawback of the present system of locomotion in London was the enormous number of vans in the streets. The public, as a whole, had to be considered, and he did not agree with any railway manager who said that there had been a great improvement with regard to railway companies' vans during the last five years. At the present time such vans, some of them as big as pantechnicons, and always a great many of them empty, caused a serious blockage in the streets. The London Chamber of Commerce had appointed a committee to look into the details of Mr. Gattie's scheme, and he might go further and say that many gentlemen, who had scientific knowledge, on the County Council had endorsed the scheme. He was sure, when it came forward in full detail, it would be greatly appreciated and better understood by the public at large.

Mr. Lewis R. S. Tomalin thought it was a most striking fact that no one had attempted to refute or to amend the figures and facts which Mr. Gattie had brought forward, which surely would have been the case if Mr. Gattie was bringing forward an impossible or mad scheme, and misleading the public. All Mr. Gattie's statements were founded on the results of an enormous amount of research and industry, and he could be trusted. He (the speaker) could remember the state of the traffic in the City for the past forty-seven years, and he maintained that the obstruction of the streets was worse at the present time than it ever was before. Mr. Gattie had not made it quite clear that evening that the collecting carts of the proposed Clearing House would be motor-wagons. Those motor-wagons would take the containers with goods to a warehouse, say, in Wood-street, the containers would be promptly hoisted off, other containers with goods going from Wood-street to the Clearing House would be substituted, and off they would go, the result being there would be very little delay or waiting of the lorries outside the warehouse, and, of course, the transit through the streets would be much more rapid. From every point of view, as a commercial man who believed, without having any scientific or expert knowledge, that he thoroughly understood the wants of London in that respect, he strongly endorsed Mr. Gattie's scheme, and trusted that the fact of his having been permitted to read his paper before such a very old and highly-thought-of society as the Royal Society of Arts, would aid him in obtaining more publicity and more support.

Mr. S. Chapman referred to the fact that most of the goods traffic arrived in London in the early morning by the means of 290 trains according to Mr. Gattie. With the most improved appliances those

290 trains could be promptly unloaded in the Clearing House, but it had occurred to him (the speaker) that at the precise moment when those trains were unloaded there would not be the corresponding amount of goods with which to reload them, and, therefore, they would be standing idle until the evening traffic came along. He also appreciated the system of contacts and the method of conveying the parcels from one section of the flooring to another, but he would like to ask one question with regard to documentation. One got as far as the documentation of the container when it had reached the floor, but if the container was to be disposed of with the greatest rapidity, how was the documentation going to be carried on from the point when the goods were unloaded from the container and distributed to various other parts of the premises? If the documentation was to be made out for each separate package at the precise moment, the time occupied in bringing it would not be quite so short as might be assumed from the author's remarks. Another point was that assuming that 2,000 wagons did the work of 10,000, and they took a shorter time owing to the facilities offered by the Clearing House, it might readily happen that a large proportion of those wagons would make two or more journeys through the streets, and if so, although the actual number was only 2,000, there would be as much congestion as if there were 5,000 or 6,000 wagons in the streets.

Mr. HENRY MURRAY said the erection of such a Clearing House would cost a large amount of money, and he inquired if the author distinctly saw his way to showing any considerable profit on the cost of that erection. Could he give any figures indicating what that profit might be reckoned at on the basis of current rates?

Mr. C. E. RATCLIFFE inquired if there would be any provision in the nature of private sidings or warehouse accommodation. Also, would any provision be made for the public to do their own carting? Many consignees had premises close to certain stations, which premises would be a long way from the Clearing House, and this would be a disadvantage to those people. Was it intended that in addition to the traffic being bulked in the Clearing House for subsequent distributions, such matters as accounts, correspondence and claims would also be dealt with there? Carrying that further, suppose one vanload contained consignments from half a dozen railway companies, how would the money be collected and redistributed to the different companies?

Mr. M. H. MATTHEWS asked if Mr. Gattie had made any special arrangements for handling goods of a special nature. It had been mentioned that the containers were 11 feet in length, which he, the speaker, supposed would be for normal traffic. He therefore presumed that bridge girders, for instance, would have to be handled at special times of the day, as at present.

Mr. W. L. MADGEN remarked that anyone having any knowledge of electrical engineering and the possibilities of endowing apparatus with selecting faculties by means of electricity, would see that sooner or later a device of the kind under discussion was inevitable. He himself did not see any serious practical difficulty in carrying Mr. Gattie's scheme into effect. He might mention one matter in which he thought the author would probably be disappointed. Mr. Gattie appeared to believe that his system of dealing with the goods traffic of the Metropolis would alleviate the congestion of the streets. He (the speaker) did not think it would. It was promised, with the introduction of tubes and every other movement in the direction of facilitating passenger and other traffic, that that congestion would disappear, but, as a matter of fact, it was worse at the present time than ever it had been. He thought there was only one solution of that, namely, an organised redistribution of industries, and one of the greatest obstacles to that was the attitude of the governing bodies of the Metropolis, including the County Council, which, they had heard that night with considerable surprise, contained some scientific men.

Mr. S. WATERS believed, as a railway man, it was possible for railway companies to remodel their system so as to make a greater use of electricity. He was glad to see that Mr. Gattie had provided for a greater use of electrical apparatus in his scheme, but the chief difficulty which he (the speaker) could see in the scheme would account also for the opposition of the railway companies themselves. Mr. Gattie's scheme would take away a very large part of the railway companies' revenue derived from the delivery of goods, and how did he propose to compensate the railway companies in that respect? Mr. Gattie proposed to have tubes running from the London goods termini into the Railway Clearing House, and proposed to transfer the goods from the railway trucks into certain receptacles which would be placed in special trays and run through the tubes into the Clearing House. He would like to inquire how that was going to be done, and at whose cost, and also who was going to do the checking which would be necessary to ensure the safe transit of the large number of articles which would go through the tubes day by day? If the Clearing House proposed to do it, it would necessitate having a large staff at the railway station. Another point was how was it proposed to determine the route that the goods should travel, and who would determine which company was to be favoured with the traffic?

Mr. GUY LIDDELL referred to the value of co-operation in the establishment of a Goods Clearing House and in that connection quoted the case of the Port of London Authority and the great appreciation in the shares of those railway companies who had some time ago entered into a working agreement. The Committee of the Board of Trade on Railway Agreements, in its

report, had also given a most favourable verdict on the principle of co-operation among railway companies in this country. Mr. Gattie had made out a good case for the adoption of his scheme. There was such an enormous amount of overlapping in regard to the collection and delivery of goods in London that a more uneconomical or unsystematic scheme could not well be imagined. The streets of London were crowded with vans competing for vulgar fractions of goods, and their presence greatly impeded the time-saving traffic. Every class of person desired a change, and he appealed for the hearty co-operation of the railway companies to carry Mr. Gattie's scheme forward.

Mr. A. G. SEAMAN said the author had called attention to the large proportion which the cost of carriage formed of the cost of articles. This country at present possessed the great economical advantage that its manufacturers were more or less concentrated within limited areas. That was not the case in America, where the more important manufacturing centres were in many cases hundreds of miles apart. Directly it was admitted, as it had to be, that the principal cost in transferring goods was not the cost of forwarding them from one place to another, but was the cost of handling the goods at the terminals, it would be found that this country was wasting a very great economic advantage which it at present possessed by its manufacturers being close together.

Mr. E. EVANS said the author had mentioned that a goods truck's life was seventeen years, and that it was only mobile on the track for six months during that time, but he (the speaker) took it that Mr. Gattie included coal trucks, which were allowed to remain at the docks waiting for shipment for a considerable time. Miles and miles of them could be seen in Wales, and it was hardly fair to take such trucks into account. With regard to the style of wagon, he took it that the containers would have to be loaded up by the cranes when the goods were loaded in close-roofed vans. That would take a considerable time for the loading-up of the containers for distribution to the different parts of the Clearing House. It seemed to him that decentralisation would relieve the congestion of the streets of London, and that was what the railway companies had done by putting depôts convenient to the places of business of their customers. If a system of concentration was adopted the congestion of the streets would be increased. Then there were receiving offices all over London. It was hardly likely they would be done away with. The only way was to adopt some system of steam, electric or motor traction for conveyance of goods, and so speed the traffic along; but that system could be adopted, and he believed was being adopted by the railway companies.

Mr. GATTIE, in reply to Mr. Evans, said that his estimate of the life of a railway goods truck and its mobility on the track was arrived at from a calculation on the whole of the goods and mineral trucks, and his answer to the question was in the affirmative. If Mr. Evans would read the copy of the London Chamber of Commerce proceedings he would see that the whole of the trucks were taken in arriving at the calculation, which showed a 3 per cent. efficiency. He had also, with very great difficulty, worked out the efficiency for the general-merchandise truck, and found it was as nearly as possible the same. With regard to the question of decentralisation, he thought he had shown that there would be 2,000 wagons on the streets instead of about 30,000 or 40,000, and the question was, which would occupy the more space? His 2,000 cars would make about four journeys, but that showed they would not be standing still. What caused congestion in the streets was not the moving but the stationary traffic. The question must be reduced to van-space minutes. If a car which went two miles an hour through the streets was taken, it would occupy the streets for the journey done exactly twice as long as a car going four miles an hour. Turning again to Mr. Evans's remarks, he would point out that the distance from the centre to any point on the circumference was the same. The car miles of the Clearing-House system, although it did not appear so at the present time, were really less than when a great number of journeys had to be made. Those were only determined by most careful calculations, diagrams and curves, which he had not had time that evening to produce. He could simply assert that it was so. With regard to the division of the moneys and the taking away of the profits made by the railway companies at the terminals, supposing there was a business which cost the railway companies 1*s*. and which cost the New Transport Company 3*d*. to do, it was clear to his mind that the railway companies might have one-third, the public might have one-third, and the New Transport Company might have one-third, and nobody would be injured. With regard to the question of the difficulties which took place in booking, the best way was to make it all through traffic. There was no difficulty in booking through between the London, Brighton Company and the South-Western Company and why should there be any more difficulty in booking things either to or from the New Transport Company? Even if the New Transport Company was regarded as a carrier company, the same thing happened every day with the eight hundred other carrier firms in London. To Mr. Chapman's question, the best answer he could give was to ask what was the documentation of the hand-truck system. He was substituting for the hand-truck an electrical apparatus which he firmly and honestly believed would do the work of eighty men, but there was no alteration involved in documentation. The belt sections he had referred to must be regarded as human machines, only they were much more efficient; they could do more work, carry heavier

loads, and did not get tired. Whatever applied to the present system of documentation and the hand-truck, equally applied to the electric system. There was also the further point that the electric carrier was absolutely honest, and therefore he thought the book-keeping need not be quite so strict as under the present system. One speaker had inquired how goods exceeding 11 feet in length would be dealt with. Such goods would not be placed in containers, because they could not be; but the Clearing House was a fairly large place, and there would not be the slightest difficulty in lifting a girder even of 60 feet length. With regard to what one gentleman had said about how traders living near to goods stations would be affected, it was very nice perhaps for a man who owned a horse and cart to be next to Bricklayers' Arms Station, for instance. It would be very easy for such a man to go into that station. But how long would his horse and cart remain there? (A voice: "For hours.") He quite agreed, and that appeared to him to be a very costly thing. According to the New Transport Company's system, one of their cars would call for the man's goods—he would not be bothered about the matter at all—and therefore that horse and cart would not be wanted. Another question asked was, Would there be any storage accommodation in the Clearing House? The answer was in the affirmative. There were 117,000,000 cubic feet of space, and that represented a large space. With regard to possible profits, that question had been gone into very carefully by chartered accountants (who, of course, could not certify anything but facts), and it had been found that taking current rates, on a revenue of £10,000,000, something over £6,000,000 a year would be saved. That was a 60 per cent. proposition. Then an important question had been asked, How could the trains be reloaded up when there were not the available goods with which to do that? His company had approached every railway company and asked for details and information. When the railway companies gave that information he guaranteed that within one calendar month the Clearing House time-table would appear which would show the time of arrival and departure of every train, what it was being loaded with and its destination. The difficulties were caused by the railway companies themselves. The New Transport Company did not intend necessarily to adhere to the exact time-tables of the railways, because those were made so as to fit in with the present arrangements. With new arrangements new time-tables would be adopted. The new Clearing House would receive a train, unload it, reload it with goods which had accumulated in the Clearing House, and send it away again, and, astonishing as it might seem, a goods train with fifty trucks could easily be unloaded and reloaded in ten minutes.

On the motion of the CHAIRMAN, a vote of thanks was accorded to Mr. Gattie, and the meeting terminated.

THE PRODUCTION OF MOCHA COFFEE.

All the Mocha coffee grown in the world comes from the Yemen, a Turkish province in the south-western part of Arabia, and is so called because the entire crop was formerly shipped from Mocha. The trade is now wholly divided between Hodeida and Aden, the bulk of it going from the latter port. Coffee can be grown successfully, probably, in any of the mountainous parts of the Yemen, but its cultivation is, in fact, confined to a few widely-scattered districts and the acreage is relatively small. This is due to the fact that the Yemen Arab never uses coffee himself, contrary to general opinion and the reports of some travellers, but cultivates it almost entirely for export. He uses "Kishar," a beverage he brews from the dried hulls in large quantities, but it is certain that he never would devote much land or labour to the cultivation of the berry for its hulls, because there would be little profit in it. In cultivating coffee for export, the Arab realises a good profit in money when his trees yield their crop and it is sold. But he must wait four years after planting, during which the cost of labour is heavy, before his trees begin to yield, and the main desideratum with him is not money but food. In a land where the barter of commodities is difficult, through lack of means of communication, money may mean clothing and comforts, but the one necessity is food, and he may not always be where he can buy food with his money. In consequence the Yemen Arab devotes little of his land to coffee, and very much excellent coffee land to dhurra, a plant resembling Indian corn in appearance but producing a grain like millet. He argues that, however superior the money-getting qualities of land planted with coffee, he gets sixteen crops of dhurra while waiting for one of coffee, and is sure that his family is safe from starvation. According to the American Consul at Aden, the principal coffee regions are in the mountains between Taiz and Ibb, and between Ibb and Yerim, and Yerim and Sanaa on the caravan route from Taiz to Zabeed; between Hayelah and Menakha on the route from Hodeida to Sanaa, and in the wild mountain ranges both to the north and south of that route; between Beit-el-Fakih and Obal, and between Manakha and Mathan to the north of Bajil. Of all Yemen or Mocha coffee the best is that known as Mohtari, from the district of Beni Mohtar lying almost due south of Sanaa. Another nearly, if not quite as good, comes from Yafi, near Taiz. Other kinds that are considered superior are Sharsh, Menakha, and Hifash. It is said that all these coffees are the same variety, and that the superior quality of any of the so-called kinds is due wholly to the curing. In Beni Mohtar the coffee lands are held by large and wealthy proprietors, whose means enable them to hold their crop for some months after it is gathered. The berries picked in September are accordingly stored away, and allowed to cure all the winter. The bean thus dries out thoroughly before it is hulled and brought to market. This accounts for the clear,

almost translucent yellow colour of the finest berries when they reach the market. The planters in the other districts, however, are compelled to sell their crop quickly in order to tide over the winter. Hence they pick the fruit before it is properly ripened and hull the berry before it is properly dried. As a result, the colour is pale and lifeless, the flavour weak and flat compared with the berry cured within the hull. So little is coffee used by the people, that a few months after the new crop has been gathered it is impossible for one passing through the country to buy a single pound except at Hodeida and Sanaa.

BRONZE CASTING IN SIAM.

According to old records, the art of bronze casting was introduced into Siam by the Chinese in the eleventh century. Bronze, however, has been known throughout Indo-China since the earliest times, as shown by the discoveries of bronze hatchets and arrow-heads in limestone caves and other places of deposit of pre-historic remains. Ancient bronze figures of Indian divinities and of the Buddha testify to the early employment of the bronze founders in these cults in Siam. Figures of the Buddha are found in the north of Siam in great numbers on the sites of ancient temples which have been crumbling for centuries, leaving the majestic bronze figures standing enclosed by great forest trees. The interesting point about these figures is the perfect condition of the bronze after centuries of exposure to a tropical sun and rains. This bronze is called by the natives "samrit"—the perfect or auspicious alloy—and its composition for a long time remained a secret, until, according to the American Consul at Bangkok, a few years ago the formula was discovered in an old Siamese manuscript belonging to the late King of Siam, of which the following is a translation:—"Take twelve ticals (one tical is equal to one half-ounce avoirdupois) weight of pure tin, melt it at a slow fire, avoiding bringing it to red heat. Pour two ticals weight of quicksilver, stir until the latter has become thoroughly absorbed and amalgamated, then cast the mixture in a mould, forming it into a bar. Take one catty in weight (eighty ticals) of refined copper and melt it. Then gradually incorporate with it the amalgam, keeping in the meantime the fused mass well stirred. When this has been done, throw into the crucible a sufficient quantity of ashes obtained from the stems of the 'bua-bok' (lotus) creeper, so as to cover the molten metal. Remove the dross with an iron ladle; the metal remaining is samrit bronze." According to this recipe, the proportion of the ingredients employed in the manufacture of the alloy in question thus proves to be 85·11 copper, 12·76 tin, and 2·13 quicksilver. One of the best known statues of the Buddha cast of samrit bronze may be seen in the city of Pitsanuloke, Siam. This figure dates from the beginning of the eleventh century, and ranks among the most beautiful objects of art that the Siamese have ever produced. Samrit bronze was also much used in old days for casting vessels and implements for sacred uses, and was supposed to be endowed with mystic qualities. The art of casting bronze Buddhas still forms quite a home industry. The method followed is to mould a figure in clay and coat it with wax, and then apply a coating of clay; the wax is melted by the application of heat and the molten metal poured in. When cold, the mould is broken, and the figure cleaned and polished. In the temples of Bangkok may be seen many fine specimens of modern statues of the Buddha, which compare favourably with those of other countries.

HOME INDUSTRIES.

The Sale of Milk.—The Acreage and Live-Stock Returns for 1910 just published, show that for the first time since 1902 the number of cows and heifers in milk or in calf have decreased, the total for 1910 being 26,500 less than in the previous year. In the North Riding of Yorkshire alone there has been a decrease of 1,235 cows and heifers as compared with 1909, and in the county of Durham a decrease of 876. It is to be noted that the decrease in 1910 as compared with 1909 is to be found in Wales and Scotland as well as England, but it is principally in England and in the north-eastern and northern districts that this decline is shown for the first time during the thirty-five years covered by these tables. Mr. Rew says that the causes of this loss are not very apparent, but it may be assumed to have been mainly due to temporary or accidental causes. It is at least remarkable that, notwithstanding the ever-increasing demand for milk by a rapidly growing population, the stock of cows is actually decreasing in Great Britain, and in the north of England decreasing in a somewhat marked degree. The explanation of this untoward change may well be found in the administration of the Sale of Milk Regulations, 1901. Milk is liable to fall below the presumptive limits fixed by the Milk Regulations, which is almost always the 3 per cent. of butter-fat. Now many farmers have been brought up in the police-courts, and magistrates have treated the presumptive standard of the regulations as being virtually an absolute standard. But the liability of the milk to fall below the presumptive 3 per cent. of butter-fat was well known before the regulations were drawn up, and was admitted by the Departmental Committee which sat in 1900. It was less generally known until recently that the dairy herds in the north of England are specially liable to give milk below the standard at frequent but irregular intervals, and from no ascertainable cause. The fact has been proved to demonstration by the publication of the results of experiments carried out on behalf of the Durham County Council at the Offerton Dairy Farm in the early part of 1909. The mixed milk of a herd of five specially-selected dairy cows was subjected to daily

analysis. The cows were liberally fed, and yet it was found that in eighty-four separate tests the morning's milk fell below the 3 per cent. standard eighty times, the weekly average of the butter-fat falling on several occasions to 2·5. Similar results followed experiments made on behalf of the North and West Riding County Councils at Garforth Experimental Farm, and much other evidence has accumulated, all tending to prove that the liability to variation in the quality of milk, particularly in the spring, is so frequent and so general that no milk-producer can hope to escape trouble with the local authorities if the sampling officers are zealous in the discharge of their duties. And they seem to be very zealous in the north, where they are encouraged by magisterial decisions that have over-much regard to the strict letter of the law. The result is widespread agitation among the farmers, who at a representative meeting at Stockton-on-Tees last week demanded the immediate suspension of the Sale of Milk Regulations, pending a full inquiry into the administration of the Sale of Food and Drugs Acts as they affect the dairying industry in the north of England. It may be hoped that the Government will see their way to accede to a request that would appear to be necessary to the well-being of a very important industry.

The Coal Mines Bill.—The Miners' Federation have drafted a clause to the Coal Mines Bill respecting the inspection of mines which, if accepted by Parliament, will compel the employment at every mine of an inspector who will be solely occupied with examining and reporting upon the safety of the mine. This inspector will have nothing to do with the production of coal. He will be engaged by the men, subject to the approval of the mine inspector, and will not be liable to dismissal except with the consent of the district inspector appointed by the men. Duplicates of his reports will have to be sent to the mine inspector every fortnight. The qualifications of these inspectors are to be fifteen years' experience in a coal-mine, five of which have been spent at the coal face, and their appointment is to be by ballot of the miners. Moreover, if the miners show by a majority that they have lost confidence in the inspector, they will have the right to compel him to submit himself to a ballot for confirmation or rejection.

Sulphate of Ammonia.—The output from coke ovens may be expected to be largely increased as a result of orders placed for batteries of ovens during recent months. They are not likely to affect the output for the current year, but must have considerable effect upon that of 1912. Sulphate of ammonia is becoming increasingly popular, and the demand is expected to be quite equal to the increased supply. To the Scotch mineral-oil trade sulphate of ammonia is a by-product of great value, and it is expected that the forthcoming reports will show that it has been a main source of profit. The price of sulphate of ammonia has risen very considerably in recent months. Recently it was over £14 per ton, and although now lower there is, at present prices, a big margin of profit, since the cost of production is not more than £5 per ton. Great Britain and Germany are the principal producers, Germany producing last year 373,000 tons against Great Britain's 369,000 tons. The United States produced 116,000 tons, France 56,000 tons, Belgium and Holland 43,000 tons, and the rest of the world 100,000 tons. Of the British production, 168,000 tons are produced at gas-works, 120,000 tons at coke and galvanising works, and from producer gas, 60,000 tons from shale, and 21,000 tons from blast furnaces. The British exports last year amounted to 248,000 tons, and the home consumption to 87,000 tons.

The Motor Liner.—There would seem to be no foundation for a report that has been current to the effect that the Hamburg-American Company has decided to abandon its experiment in the construction of a motor liner. On the contrary, the Company is understood to have just placed a contract for a similar vessel with a Bremen firm, and has the intention to order an even larger boat than the two of 6,500 tons each now on order. It is said that other German companies, including the Hamburg-South American Company, also have ocean-going motor-boats in course of construction, whilst the Danish East Asiatic Company is building two for its New York service, one on the Clyde and another at Copenhagen. A Tyne-built oil-engined vessel, the "Toiler," will be the first of the kind to cross the Atlantic, but it must be admitted that the pioneer work has been mostly done by foreign companies. It looks, however, as if there will be more activity in home ports in this connection before long. A motor cargo-boat of considerable size is being built for Lord Furness, and an order was recently given for an oil-tanker of 6,000 tons, which is to be fitted with Diesel engines.

Trawling and the Three Mile Limit.—Considerable sympathy must be felt with those who are endeavouring to induce the Government to extend the three mile limit within which fishing by means of beam or "otter" trawl is at present prohibited. In recent years the position has been completely changed by the steam trawlers, now so common. Their methods are terribly wasteful and destructive, not only of fish, but of fish-spawn, and in many districts the line fishermen, who in Scotland number some 13,000 men and boys, find their occupation almost gone. The representatives of the line fishermen are urging the Government to recover freedom of action for this country, which is at present bound by the North Sea Convention, and by international agreement, to fix a general twelve mile limit against steam trawlers. It will be remembered that Russia has recently put in force a twelve mile limit in the White Sea, a proceeding against which the British Foreign Office has protested. But having regard to the havoc

wrought by the steam trawler, there would seem to be a good deal to be said for imitating Russian procedure in this respect. It cannot be to the national advantage to see the line fishermen disappear, and this is what must happen if they are not to be more fully protected against the depredations of the trawler.

Ireland's Canals.—The final report of the Royal Commission on the canals and inland navigation of Ireland has now been issued. It recommends the creation of a controlling authority for the purpose of taking over those inland waterways which are already under the control of the State, of local authorities, or of a public trust, and of acquiring such other waterways as are determined to be of importance. This controlling authority, the Commissioners consider, should be entitled the Water Board, should form a branch of the Department of Agriculture for Ireland, and should consist of three or five Commissioners, one of whom should be paid and give his whole time to the work. Lord Farrer does not sign the report, because in his opinion there ought to be no further administrative changes in Ireland involving a charge on the public purse unless and until a purely Irish elected authority has agreed to pay for them. Lord Farrer is alarmed at the growth of public expenditure in Ireland, which, in his opinion, will not be checked unless the people who benefit have themselves to pay for public improvements. The commodities carried by Irish canals consist mainly of coals, bricks, timber, sand, turf, oats, flour and grain, and such agricultural requisites as artificial manures, grass seeds, etc., besides a fair proportion of general cargo. They are, therefore, calculated materially to benefit the farmer if their efficiency is maintained.

The Manning of British Ships.—Considerable discussion has arisen upon a letter addressed by Messrs. Glen & Co. to an official of the Seamen's Union who had protested against the practice of the Company in employing Chinese as firemen in their steamers. Messrs. Glen & Co. say that this preference is not due to motives of economy. The wages are practically the same as with Europeans. But Messrs. Glen & Co. go on to say that they "would be quite prepared to pay considerably higher wages to Chinese than we would to Britishers, as they are much more sober and steady, and do their work much more efficiently." That is not a statement that can be supported by adequate evidence. It may be more or less true, as Mr. Cuthbert Laws, the General Manager of the Shipping Federation, says, of the tramp steamship that goes anywhere, with no fixed route; but is certainly not true of vessels trading regularly from port to port—the home coasting trade and liners both in the foreign and home trade. In certain Eastern trading vessels that are away from home for irregular periods the Chinese, for many purposes, are preferred. They are better adapted to the climate, and do not get restive, want to get home, and finally desert their ships, as the British sailor does. But it is not well to generalise too much. Chinese and other foreign seamen are preferred by many skippers because they do not resent ill-treatment, physical ill-treatment, as the British sailor does. It is, oftener than not, the skipper rather than the owner who prefers the Chinaman or Lascar.

The Motor-Cab Industry.—It is too soon to speak with any certainty as to the prospects of the motor-cab industry and its attractions (if any) for the investor. It is obvious that the industry has great and exceptional difficulties to face. The operating companies are pioneers. The industry is only about six years old. In 1905 there were only nineteen motor-cabs in service in London, in March, 1910, the number had increased to 7,165, and since then there has been a large addition to the number on the streets. But the data are still wanting to enable a decided opinion to be formed as to depreciation and reserve; it is still a matter, more or less, of speculation as to how long rolling-stock will last, and this question goes to the bottom of the business. Nor is the period of the serviceable life of a motor-cab the only one of vital importance with which the existing companies have to reckon. There is a steady improvement in design which threatens to make stock obsolete earlier than it would be from fair wear and tear. And of course competition has to be faced. If the present companies are able to show large profits others will soon be appealing to the public for capital, which will be subscribed under the glamour of large dividends—not that there is much likelihood, so far as can be seen, of such dividends. The oldest and most important of the operating companies, formed five years ago, paid its 7 per cent. preference dividends for the last two years, but the net profit, which for 1908-9 was stated at £225,553, fell in the year ended July 31st, 1910, to £201,525. The second company on the list made a net profit in the financial year ended October, 1910, of £22,064, but the directors did not consider themselves justified in recommending a dividend. A third company has issued accounts for a period of fourteen months to July, 1910, which show a net profit of £5,509, but the other companies have not, as yet, issued any accounts. There is nothing in the available information to modify the opinion expressed in these Notes a year ago that shares in the motor-cab companies must necessarily represent a highly speculative, and therefore, from the prudent point of view, undesirable investment.

NOTES ON BOOKS.

WILLIAM FORD STANLEY. Edited by Richard Inwards. London: Crosby Lockwood & Co. 2*s*. 6*d*. net.

The first five chapters of this slender volume are autobiographical, and give an interesting account

of a remarkable man who rose by sheer ability, persistence and courage, from the smallest beginnings to a position of very considerable influence and wealth. Thanks to the unpractical nature of his father, who, though an excellent mechanic, was cleverer at losing than at making money, young Stanley got no better education than was to be had at a village school—where he learnt spelling, writing and hymns—and a small private school, kept by an ex-bank clerk, who had lost his situation through drunkenness. The lad, however, if he learnt little from his teachers, possessed the art of self-education. Compelled to begin earning his own living at the age of fourteen, he attended classes at the Birkbeck Institution after a ten hours' day of hard manual labour, and, being a diligent student, he soon gained a fair knowledge of English literature, technical drawing, and modelling. After several changes he found himself, at the age of twenty-five, master of one hundred pounds, and he then decided on the step which finally led him to fortune. He took a little shop at 3, Great Turnstile, Lincoln's Inn, and set up there as a maker of drawing instruments. By various improvements which he introduced—notably in the tee-square and the theodolite—Stanley's instruments soon became favourably known to architects and engineers, and he built up the business which has now large factories at Lincoln's Inn, Norwood, London Bridge, and Great Turnstile.

Stanley's autobiography ends about this point, but the rest of the story is told in a few short chapters by the editor, who sketches the character of a very lovable and accomplished man. One of the last acts of his life was the building and endowment of the Stanley Hall and Technical Schools at Norwood, at a cost of some fifty thousand pounds. As he himself said, "he was moved to this enterprise by the painful sense of his own imperfect education, and he was determined that at least some of the rising race should not lack proper teaching." In this institution, Stanley's own views on the ideal technical school are carried out. An hour and a half of book learning or lecture alternates with an hour and a half practical work at the bench, vice or lathe, and by this change of occupation the interest of the students is kept constantly awake.

Mr. Inwards has produced an interesting little volume, which should prove a great encouragement to those who have to make their own way in the world.

The English Staircase. By Walter H. Godfrey. London: B. T. Batsford. 18*s*. net.

In this work Mr. Godfrey gives an historical account of characteristic types of the English staircase, the main body of which belongs to the period 1500 to 1800. As he modestly states, no attempt has been made to write an exhaustive treatise on the subject, but he has been at great pains to collect drawings and photographs of interesting and beautiful specimens, with the result that we have sixty-three full-page plates and over fifty other illustrations. As the work has been published by Mr. Batsford, it is hardly necessary to add that these have been admirably reproduced by the collotype process.

After giving an illustrated outline history of the stone staircase from Norman to Tudor days, Mr. Godfrey describes the new methods of the Early Renaissance, the Jacobean type, and the quiet dignity of the Later Renaissance. The graceful elegance of the Georgian stair, and the application of ironwork to the later design, conclude his review.

Mr. Godfrey in his preface laments that in the general decline of domestic architecture which took place during last century, the staircase reached a lower level than any other feature. It is still far too often cramped into a narrow and badly-lighted well, mainly, no doubt, with the object of curtailing as little space as possible from the rooms; but when one sees how beautiful and striking a feature it may become, one cannot but hope that the architects of the future may be inspired by Mr. Godfrey's book to restore to it some of the splendour of the past.

GENERAL NOTES.

Memorial Tablets. — The London County Council have affixed a memorial tablet to the house known as The Grove, Hampstead, which was from 1856 to 1864 the residence of Sir George Gilbert Scott, architect. The two chief works on which he was engaged at this period were the erection of the Foreign and India Offices in Whitehall, and the preparation for the Albert Memorial. A tablet has also been erected on No. 32, Soho Square, well known as the residence of Sir Joseph Banks, who was for over forty years President of the Royal Society. The house became famous as "a sort of academy of science—the rallying point of science and genius of all countries."

Forestry in Japan.—In a paper entitled "Some Statistics of Japan," recently read before the Royal Statistical Society, Mr. Charles V. Sale gave some interesting particulars relating to Japanese forestry. About 60 per cent. of the area of the country is covered by forests. Of this the State owns 29,186,850 acres; the Crown, 6,152,350 acres; communities and temples own 6,632,150 acres; and private owners, 14,112,000 acres—a total of 55,083,350 acres. "The importance of forestry," writes Mr. Sale, "has been recognised from very early times, and during the Tokugawa *régime* (1603-1867) the most stringent protective rules were enforced. Inasmuch as wood was the only fuel and the only building material, whether for houses or boats, it was necessary that each feudal domain should secure a constant supply of the different timbers within its own borders. Hence arose the practice of regarding the production

of timber in the same light as that of crops, and of enforcing a certain rotation with given periods for cutting and replanting. With the fall of feudal government these restrictions were removed, and for a time there was much reckless felling of timber, especially where it was within easy reach of a market, but in the year 1882 draft forest laws were prepared by officers who had been trained in Germany, and in 1899 the general Forest Law was promulgated. Under this law the State and Crown forests are administered, and the cutting of other forests is regulated. Hitherto, the Forestry Bureau has been principally engaged in laying down the system of management and control. The country is divided into ten districts, with 270 local offices and 1,259 sub-offices. The State forests are all to be managed as a trading concern, small isolated areas are being sold so as to consolidate the estates, and a very considerable amount of replanting is being undertaken—about 100,000,000 trees per annum. The revenue from State forests is expected to increase year by year, and to amount to some millions sterling per annum within two or three decades." The rate of progress during the last ten years has been very striking, the total revenue having risen from £196,882 in 1900 to £968,811 in 1909.

The Iron Industry of Elba.—A great increase in the output from the rich deposits of iron ore in the island has been made during the last few years, as will be seen from the following figures taken from a recent report issued by the administration of the Elban mines and metallurgical works. The introduction of modern plant and machinery for the working of the mines, as well as the treatment of the ore by up-to-date processes is now giving excellent results. There are about thirteen miles of railway with eight locomotives and 1,500 trucks for the transport of the ore from the various mines to the works and coast. Several lines of aerial rope transporters have also been constructed, and three others are nearly completed. The facilities for shipping the ore have been considerably increased during the last few years, and it is now possible to load vessels of larger tonnage than was formerly the case. 510,701 tons of ore were shipped last year as compared with 207,664 tons during 1909. The production of pig iron last year amounted to 156,004 tons, whilst that of Bessemer steel for the same period was 66,862 tons, as compared with 28,028 tons of the previous year.

International Silk Congress, Turin. — An international silk congress is announced to be held at Turin, on September 21st, 22nd, and 23rd, 1911, to which delegates from the various institutions and associations connected with the silk industry, the Chambers of Commerce, as well as persons connected with establishments for the "conditioning of silk" of all nations are invited. Other persons interested in the silk trade may attend, on payment of a fee of 20 lire (16s.) to cover the cost of printing, etc.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

May 10.—Hal Williams, M.I.Mech.E., M.I.E.E., "Beet-Sugar Factories." The Earl of Denbigh, C.V.O., will preside.

May 17.—Professor Raoul Pictet, "Les Basses Températures."

May 24.—Frank M. Andrews, "Architecture in America." Sir Aston Webb, C.B., R.A., F.R.I.B.A., will preside.

Indian Section.

Thursday afternoon, at 4.30 o'clock:—

May 25.—W. R. H. Merk, I.C.S., C.S.I., LL.D., "The N.W.F. Province of India." The Earl of Minto, K.G., G.C.S.I., G.C.M.G., G.C.I.E., will preside.

Colonial Section.

Tuesday afternoon, at 4.30 o'clock:—

May 9.—F. Williams Taylor, "Canada and Canadian Banking." His Grace the Duke of Argyll, K.T., G.C.M.G., G.C.V.O., will preside.

Cantor Lectures.

Monday Evenings, at 8 o'clock:—

Alfred E. H. Tutton, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

Syllabus.

Lecture II.—May 8.—*The Internal Structure of Rock Crystal, and the Means we possess of Elucidating it.* The Chemical Molecules of Silica, and their Arrangement in a Space-lattice — The Influence of the Arrangement of the Elementary Atoms in the Molecule of Silica in Determining a Right or Left-handed Screw Structure—The probable Disposition of the Atoms and Molecules in the Right and Left Varieties of Quartz, and the Effect of this Internal Structure in determining the Outward Geometric Form—Revelation of the Oppositely Helical Structure by Etching and Liquid Cavities.

Lecture III.—May 15.—*Optical Evidence of the Two Complementarily Opposite (Mirror-image) Screw Structures.* Rotation of the Plane of Vibration of Polarized Light in Contrary Directions by the Two Varieties of Quartz—Experiments on the Artificial Reproduction of the Quartz Phenomena, in proof of the suggested Screw Structure—The Twinning of Quartz and Apparent Enhancement of the Symmetry and Destruction or Modification of the Optical Activity thereby—The Interesting Case of Amethyst—The Magnificent Polarization Phenomena of Twinned Quartz.

Lecture IV.—May 22.—*Scientific and Industrial Uses of Rock Crystal.* Its Thermal and Electric Properties, and its Transparency to Ultraviolet Rays—The Construction of Prisms and Lenses (including spectacles) of Rock Crystal, and their Advantages over Glass—The Use of Quartz

for Balance Weights and in connection with the Interferometer—The Artistic Use of Quartz for the Carving of Vases and other Objects—Destruction of the Crystalline Structure by Fusion, and the Uses of Fused Silica in Fibres and Scientific Apparatus.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 8...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Dr. A. E. H. Tutton, "Rock Crystal: its Structure and Uses." (Lecture II.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Brewing, Institute of (Scottish Section), Caledonian Station Hotel, Edinburgh, 8 p.m. Mr. A. J. Heslop, "The Washing and Aeration of Barley."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. J. J. Done, "Development of Building Land."

Geographical, Burlington-gardens, W., 8.30 p.m. Mr. J. A. J. De Villiers, "Foundation and Development of British Guiana from Unpublished Documents."

Victoria Institute, 1, Adelphi-terrace House, W.C., 4.30 p.m. Professor F. F. Roget, "A Life Contribution to the Harmony of Christianity, Philosophy and Science."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. Sir George Reid, "The Past, Present, and Future of Australia."

TUESDAY, MAY 9...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Mr. F. Williams Taylor, "Canada and Canadian Banking."

Illuminating Engineers, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Annual Meeting.

Asiatic, 22, Albemarle-street, W., 4 p.m. Anniversary Meeting.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. J. E. C. Bodley, "The Institute of France."

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Mr. R. I. Pocock, "On the Palatability of Some British Insects." (Experiments made in the Society's Gardens with Arthropods (chiefly Insects) and Molluscs, and Notes on the Significance of Mimetic Resemblances.) 2. Professor Gilbert C. Bourne, "Contributions to the Morphology of the Group Neritoidea of Aspidobranch Gastropods. Part II. The Helicinidæ." 3. Mr. J. J. Lister, "On the Distribution in the Pacific of the Avian Family Megapodidæ."

WEDNESDAY, MAY 10...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Hal Williams, "Beet-Sugar Factories."

Biblical Archæology, 37, Great Russell-street, W.C., 4 p.m.

Geological, Burlington House, W., 8 p.m.

Automobile Engineers, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 8 p.m. Mr. L. A. Legros, "The Use of Pressed Steel in Automobile Construction."

Engineers, Junior Institution of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 7.30 p.m. Mr. F. J. Hawkins, "Notes on Illumination by Gas and Electricity."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 5.45 p.m. Mr. R. W. Vawdrey, "Reinforced Concrete." (Lecture III.)

THURSDAY, MAY 11...Iron and Steel Institute, at the Institution of Civil Engineers, Great George-street, S.W., 10.30 a.m. Annual Meeting. 1. Messrs. Felix A. Daubinè and Eugène V. Roy, "Note on a Process for the Desiccation of Air by Calcium Chloride." 2. Mr. J. E. Stead, "On Welding up of Blowholes and Cavities in Steel Ingots." 3. Messrs. E. F. Law, W. H. Merrett, and W. Pollard Digby, "On Some Studies on Welds." 4. Dr. J. N. Friend and Mr. J. H. Brown, "On the Action of Aqueous Solutions of Single and Mixed Electrolytes on Iron." 5. Mr. Percy Longmuir, "On the Corrosion of Steel." 6. Mr. J. W. Cobb, "On the Relation of Impurities to the Corrosion of Iron." 7. Mr. E. Adamson, "On Temperature Influences on Carbon and Iron."

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Roman Studies, Society for the Promotion of, Lecture Theatre, Burlington-gardens, W., 4.30 p.m. Inaugural address by the President, Professor F. Haverfield.

Royal Institution, Albemarle-street, W., 3 p.m. (Tyndall Lecture.) Professor R. W. Wood, "The Optical Properties of Metallic Vapours." (Lecture III.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Professor H. E. Armstrong, "Leaf Studies."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Mr. J. S. Heather, "The Driving of Winding Engines by Induction Motors."

Architects, Society of, 28, Bedford-square, W.C., 8 p.m. Mr. A. Saxon Snell, "Hospitals."

FRIDAY, MAY 12...Iron and Steel Institute, at the Institution of Civil Engineers, Great George-street, S.W., 10.30 a.m. Annual Meeting. 1. Mr. H. C. H. Carpenter, "On the Growth of Cast Irons after Repeated Heatings. Parts II., III. and IV." 2. Messrs. J. O. Arnold and A. A. Read, "On the Chemical and Mechanical Relations of Iron, Chromium and Carbon." 3. Messrs. A. McWilliam and E. J. Barnes, "On the Influence of 2 per cent. of Vanadium on Steels of varying Carbon Content." 4. Mr. W. H. Hatfield, "On the Influence of Vanadium upon Cast Iron." 5. Messrs. C. H. Ridsdale and N. D. Ridsdale, "On Mechanicalising Analysis as an Aid to Accuracy and Speed for Commercial Purposes."

Royal Institution, Albemarle-street W., 9 p.m. Professor W. Stirling, "Biology and the Cinematograph."

Malacological, Burlington House, W., 8 p.m. 1. Dr. W. H. Dall, "Some Remarks on the Nomenclature of the *Veneridæ*." 2. Mr. G. B. Sowerby, "Description of a New Species of *Conus* from South Africa." 3. Rev. A. H. Cooke, "A Modification in the Form of Shell (*Siphonaria Algesiræ*) apparently due to Locality."

Astronomical, Burlington House, 5 p.m.

African Society, Trocadero Restaurant, Shaftesbury-avenue, W., 8 p.m. Sir H. Hesketh Bell, "Recent Progress in Northern Nigeria."

SATURDAY, MAY 13...Metals, Institute of, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 8.30 p.m. Dr. G. T. Beilby, "The Hard and Soft States in Metals."

Royal Institution, Albemarle-street, W., 3 p.m. Professor Selwyn Image, "Walter Pater: or, the Connoisseur and Art."

Municipal and County Engineers (Midland District Meeting), Town Hall, Stratford-on-Avon, 11 a.m. 1. Mr. Roden Dixon, "Notes on Stratford-upon-Avon Municipal Work." 2. Mr. H. D. Bell, "General Description Sewage Disposal Works." 3. Visits to Municipal Works, etc.

Journal of the Royal Society of Arts.

No. 3,051. VOL. LIX.

FRIDAY, MAY 12, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

Monday, May 15th, 8 p.m. (Cantor Lecture.) Alfred E. H. Tutton, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." (Lecture III.)

Wednesday, May 17th, 8 p.m. (Ordinary Meeting.) Professor Raoul Pictet, "Les Basses Températures."

CANTOR LECTURE.

On Monday Evening, May 8th, Dr. Alfred E. H. Tutton, M.A., F.R.S., delivered the second lecture of his course on "Rock Crystal: its Structure and Uses."

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

Tuesday Afternoon, May 9th, His Grace the Duke of Argyll, K.T., G.C.M.G., G.C.V.O., in the chair. A paper on "Canada and Canadian Banking" was read by Mr. F. Williams Taylor, London Manager of the Bank of Montreal.

The paper and discussion will be published in a subsequent number of the *Journal.*

CONVERSAZIONE.

The Society's Conversazione will be held, by permission of the Trustees of the British Museum, in the Galleries of the Natural History Museum, South Kensington, on Tuesday Evening, May 30th, from 9 p.m. to 12.

The Reception, by Sir John Cameron Lamb, C.B., C.M.G., Chairman, and the other Members of the Council, will be held in the Central Hall from 9 to 10 p.m.

A Selection of Music will be performed by the Band of H.M. Royal Artillery, in the Central Hall, commencing at 9 o'clock.

A Vocal and Instrumental Concert will be given in the Fish Gallery and a Miscellaneous Entertainment in the Shell Gallery, under the direction of Mr. Patrick Kirwan, commencing at 9.30 p.m.

The following portions of the Museum will be open:—

The Central Hall, containing cases of specimens illustrating Mimicry; Adaptation of Colour to surrounding conditions; Protective Resemblance; etc. Also specimens illustrating the Food of Fishes, and the Life History of the Eel (East of staircase).

The North Hall, containing the collection of Domesticated Animals.

The Bird Gallery, containing groups of British Birds and Nests; and in the Pavilion, at the West end, an exhibition of the Land and Fresh-water Vertebrate Animals of the British Isles.

The Fish Gallery, containing the Great Basking Shark, the grotesque Deep-sea Fishes (case 44), the Tunny (case 38), the Tarpon and Angler-fish (case 27), and the Lemon-Sole (case 30), etc.

The Shell Gallery, including a life-size model of a Giant Squid (Newfoundland), and of a Giant Octopus (California).

The East and West Corridors on the First Floor, containing the Okapi, African Antelopes, and Giraffes.

Light Refreshments will be supplied at Buffets in the North and South Corridors on the First Floor of the Museum, and at the end of the Bird Gallery.

Visitors travelling by the District Railway (or other underground railways in connection therewith) will be allowed free use of the company's subway, which leads from South Kensington Station direct into the grounds of the Museum.

Each member is entitled to a card for himself (which will not be transferable) and a card for a lady. (These cards will be issued shortly.) In addition to this, a limited number of Tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5*s.* each, if purchased before the day of the Conversazione. On that day the price will be raised to 7*s.* 6*d.*

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary at the Offices of the Society, John-street, Adelphi, W.C. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

The Council reserve the right of stopping the sale of tickets or of raising the price, if it is found necessary, in order to restrict the number of visitors within reasonable limits.

Further particulars as to the musical and other arrangements will be given in the Programmes, which will be distributed on the evening.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A Meeting of the Indian Section was held on Thursday, April 27th, 1911, Sir Arundel T. Arundel, K.C.S.I., presiding.

The Chairman, in introducing the lecturer, said Sir Thomas Holland went to India in the year 1889 as a Fellow of Owens College, and joined the Geological Survey shortly afterwards. In 1903 he was appointed by Lord Curzon Director of that department, which post he held for six years, when he completed twenty years' service. Sir Thomas had held various other official appointments in India, and his work had met with the approbation of the Government, who had conferred upon him a knighthood. He had also been made a Fellow of the Royal Society and a Doctor of Science. He had, moreover, received a unique compliment from the commercial community of Calcutta and Bombay in being asked to sit for his portrait by the Hon. John Collier, in order that there might be a permanent record of his connection with India.

The paper read was—

THE TREND OF MINERAL DEVELOPMENT IN INDIA.

By Professor Sir Thomas H. Holland, K.C.I.E., D.Sc., F.R.S.,
Late Director, Geological Survey of India.

Introduction.

The purely descriptive aspect of mineral occurrences in India has been treated sufficiently for present requirements in a series of official publications issued during my term of office as Director of the Geological Survey.* In this paper, therefore, I propose to review only those facts that are essential for a fair discussion of the practical lessons to be derived from past developments. Being no longer tied by official reticence, I am free to initiate discussion on topics about which, like many other Indian questions, there is still much prejudice in this country, prejudice largely due to insufficient knowledge and imperfect appreciation of the serious changes which have recently occurred in the balance of economic, social and political forces. My object thus is frankly to provoke discussion, but in the firm belief that the attitude of the Government to mineral questions is one which will safely bear honest critical examination.

The average investor in this country still entertains a vague impression that the India of to-day is the India of the nineties, when the Government rules for the grant of mineral licences and leases were apparently likely, if not actually designed, to clean out the wheat of honest investment with the tares of speculation, and when violent variations in exchange made it impossible for the capitalist or mining venturer to be certain that even the face-value of his stock could be realised again in gold.

Stability of Exchange.

Two reforms which were of the greatest importance in the development of Indian mineral industries took effect in 1899. In May of that year a series of rules, prescribed by the Secretary of State during Lord George Hamilton's administration, were gazetted by the Government of India for regulating the grant of prospecting licences and mining leases in British

* "Review of the Mineral Production of India during the years 1898 to 1903" (*Records, Geological Survey of India*, Vol. XXXII., Part 1); *Imperial Gazetteer*, Vol. III., 1907, Chapter III.; "Sketch of the Mineral Resources of India, Calcutta, 1908"; "Review of Mineral Production during 1904 to 1908" (*Records, Geological Survey of India*, Vol. XXXIX.). References to papers on special minerals are given in these summaries.

India. In September of the same year, as the outcome of the Government policy of restricting the coinage of silver in the Indian mints, it became possible to declare a gold standard of currency, with a fixed exchange at the rate of 15 rupees to the sovereign. The new rules for granting mineral concessions removed most of the undesirable restrictions imposed by those that had been in force since 1894. The new stability of exchange made it possible for the English investor to be certain of the nominal value of his capital outlay, and of the worth of his dividends. Both reforms were, however, effected so quietly that for some years their reality was not fully appreciated, and even now the ordinary investor retains a vague impression that the policy of the Government of India is unsympathetic, if not inimical, to the interests of the mining venturer. The changing attitude of public opinion, in India and at home, with regard to the financial policy of the Government, has been demonstrated by Mr. Reginald Murray, in his paper on "Banking in India," which was read before this Society on January 19th last;* the other subject now remains to be examined.

Mining and Prospecting Rules.

One incident should be sufficient to illustrate the general ignorance and persistent prejudice recently prevailing with regard to the mineral policy of the Government of India. In 1904 one of the Members of the Viceroy's Council (who can be assumed to have known the general feeling of financial circles at home) recorded in the secretariat, as a simple, unqualified and incontrovertible statement, that the Indian rules for the grant of mineral licences and leases were generally recognised to be obstructive and calculated to prevent mineral development, and he accordingly called for an examination of the laws in force in the colonies. As the outcome of this demand, the most recent laws controlling mining enterprise in the colonies were gathered together, and compared with the rules now in force in India. It then became evident that the Indian rules framed by Lord George Hamilton were based largely on colonial legislation, but with limitations made evidently and purposely liberal, not only in regard to areas of concessions, but also in regard to rents, royalties, shapes of blocks and periods of tenure.

Nevertheless, complaints appeared from time to time, either regarding the nature of the rules, or the way in which they were administered by district officials. Although, naturally, only those who have grievances, real or fancied, make complaints, while the satisfied residue discreetly keep silent, it is evident that a certain amount of revision is now desirable, partly because of the way in which some of the rules, as at present worked, lend themselves to variety in their local interpretation, but mainly because of the industrial and economic changes which have occurred in India during the past ten years. While in charge of the Geological Survey, I invited owners of mineral concessions, prospectors and miners, freely to record their views regarding the policy indicated by the rules as well as regarding their local interpretation. As the outcome of correspondence and conversation with those who were thus really affected, I received abundant testimony regarding the generous nature of the rules as a whole, a certain number of specific complaints about the way in which they were applied by district officials, but only a few objections to the spirit of the rules themselves. It became increasingly evident, as the inquiry developed, that complaints of a general kind occasionally heard were due largely to the supposed survival of the objectionable features which made the old rules so obstructive. The returns of mineral concessions taken in Government lands year by year offer a partial demonstration of the beneficial effects of the revised policy of 1899. These returns are summarised in the accompanying table:—

TABLE I.

Summary of the Mineral Concessions granted in Government Lands during the Years 1899-1909.

Year.	Mining and Prospecting Licences.	Exploring Licences.	Total.
1899	47	13	*60*
1900	61	11	*72*
1901	89	15	*104*
1902	89	16	*105*
1903	84	16	*100*
1904	125	26	*151*
1905	145	44	*189*
1906	211	41	*252*
1907	539	61	*600*
1908	579	237	*816*
1909	550	143	*693*

* *Journal of the Royal Society of Arts*, Vol. LIX., February 3rd, 1911, p. 263.

These figures only partially reflect the activity of prospectors in India, for we have no complete returns regarding concessions granted in Native States and by the numerous zemindars, who own mineral as well as surface rights. Owing to a reason which will be obvious to any student of Indian history, Government lands are not those which are most conspicuously mineral-bearing; for the control of the old East India Company extended—let us charitably assume, by accident—over the areas most conspicuously rich in agricultural products, the value of the wealth below the surface being so completely overlooked by the Company officers that the minerals in Bengal, for instance, were ceded with the surface rights simply by a careless wording of the Permanent Settlement in the areas now known

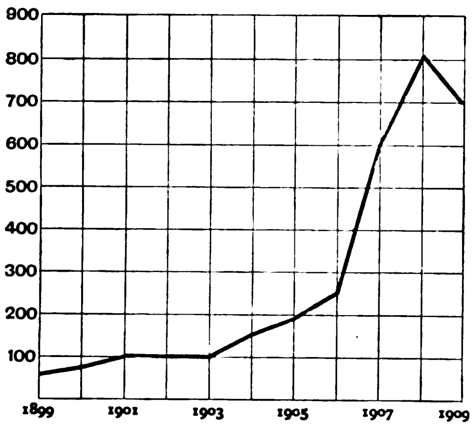

FIG. 1.

NUMBERS OF MINERAL CONCESSIONS GRANTED IN GOVERNMENT LANDS ONLY, 1899-1909.

to be so remarkably rich in coal. The annual returns for the grant of mineral concessions, however, show that the mineral policy of the Government, whatever may be its shortcomings, is capable of an immediate response to the activity of prospectors; for the rapid increase in the number of concessions granted between 1906 and 1908 is mainly due to licences and leases taken up to meet the temporary "boom" in manganese ore.

In 1908 the Government of India appointed a small committee, including representatives of the commercial community, to consider the question of revising the rules for the grant of mining concessions; and, as a consequence of the report of this committee, a certain number of modifications have now been proposed. Some of these, it is hoped, will meet well-founded complaints against the old rules; but, on the whole, the representations made by the mining community tend as much towards increased restriction as towards generosity of concession; for restrictions and safeguards are necessary, not only in the interests of the country as a whole, but for the protection of the real investor as opposed to the mere speculator. Increased stringency is required in defining boundaries of concessions applied for, to prevent unscrupulous pirates from "jumping" the claims of real prospectors, while regulations are required to enforce vigorous and continuous work in a workmanlike manner, to deal with those who do not blush to ask for concessions larger than they ever hope to work themselves. While the proposed new rules will probably favour the honest investor, they will be regarded as objectionable by the professional company promoter, who is sometimes more hopeful of exploiting metalliferous pockets through the Stock Exchange than those provided by Nature on land granted by Government for mining operations. Above all, it is hoped that the new rules will meet the numerous and often well-founded complaints against delays in dealing with applications for licences and leases. Purely administrative measures during the past few years have greatly reduced such delays, but they were in part due to a too literal interpretation by district officials of the rules themselves.

In addition to a number of minor changes, it is proposed to simplify the old system of requiring a Government certificate of approval with each application for a licence or lease. The working of the old rules in this respect was the most fruitful of all sources of delay in dealing with applications. It is proposed also to abolish Government control over the transfer of licences and leases, and a concession holder, therefore, under the new rule, may, when forming a company to work his concession, proceed with absolute certainty of being able to transfer his rights. The old rules for the grant of exploring licences will probably be abolished, as anyone in India is at liberty to search the surface of unoccupied and unreserved Government lands without a licence of any sort. The proposed rules, having been issued to all local governments, to the chambers of commerce, and to the mining associations, for criticism, have, in the main, met with general approval. The criticisms received are now under consideration before submission of the draft rules to the Secretary of State for sanction.

There is one conspicuous and serious defect, however, which for the present it is impracticable to remove. No general provision is made for

granting a claim on water-rights in areas leased for mineral working. To the miner, who knows that an abundant water-supply is necessary for most forms of mineral-dressing, this will be regarded as a serious drawback. It should be remembered, however, that in a country like India, where Native States and zemindaris are so dovetailed with one another and with British territory, it is impossible in general rules applicable to the whole Empire to guarantee water-rights in streams which cross various territories. Clauses granting, so far as is possible, claims on water are included in most leases, while in some cases it might be possible in future to frame special rules for certain provinces; but wherever the population is thick and other industries, from the nature of the country, predominate, only certain of the minerals less dependent on a large water-supply can be guaranteed by the Government this important advantage.

Progress in Mineral Production.

I propose now to give a general sketch of the progress recently made in mineral development, and then to make special reference to the most conspicuous among the products worked, but obviously nothing more than a brief outline is possible in a single paper. The accompanying diagram and table show the gradual increase

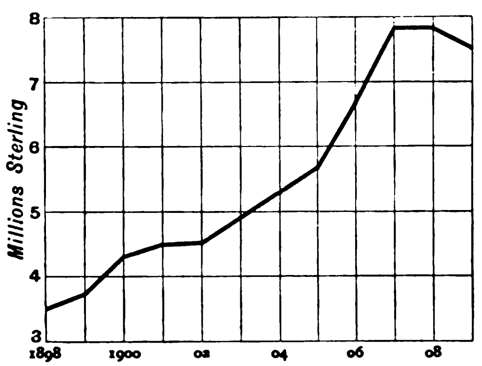

Fig. 2.

Total Annual Values of the Sixteen Principal Minerals Raised, 1899–1909.

in the annual value of those materials for which reliable and regular returns are obtainable. There are many minerals for which only partial and varying returns are obtainable; the table thus does not represent the real totals, but, as it includes the same minerals throughout the whole period, it fairly represents the rate of progress recently made, the increase in total value from 3¾ to nearly 7½ millions sterling being at the rate of just 100 per cent. for the period of eleven years. (Table II.)

TABLE II.

Total Values of the Principal Minerals Raised during the Years 1899–1909.

Year.	Total Value.
1899	£3,734,420
1900	£4,338,025
1901	£4,492,416
1902	£4,513,283
1903	£5,047,201
1904	£5,364,016
1905	£5,721,774
1906	£6,751,347
1907	£7,863,656
1908	£7,880,832
1909	£7,499,228

The values which contribute to the totals in Table II. are, in most cases, only pit-mouth *prices*, and are thus less than the actual market values. This feature brings out the most prominent and most serious defect in the nature of the Indian mineral industries. Minerals like manganese ore, mica, jadeite, chromite, and saltpetre, are raised almost entirely for export, and thus contribute to the industrial development of other countries which give, by way of compensation, to India only a fraction of the market value of the minerals, the freight charges to the areas of consumption being often greater than the pit-mouth values. The manganese-ore deposits are the most conspicuous among those which are being depleted without corresponding compensation to the country. Since the commencement of manganese-mining in India in 1892, the production has amounted to just 4½ million tons of high-grade ore, the whole of the mineral being sent out of the country. Taking into consideration the variations in price during the whole period, this product would be worth about 5½ millions sterling at Indian ports, and nearly 8 millions in the European market. Against this loss the Government and Native States between them have received in royalty not more than about £56,000, while a portion of the estimated value has been spent on labour and transport in India.

The loss to the country, however, is but imperfectly measured by the difference between the sale-value of the ore in the European market and the amount paid in India in the form of royalty and mining costs. The ore exported, being of high grade, would, if the metallurgical industries of India were developed, be largely converted into ferro-manganese on the spot, the excess beyond the country's requirements being then exported at a price about four times that of the ore. As India is a large importer of steel, the manganese purchased in this form has to pay the cost of transport to Europe and the manufacturer's profits, as well as the return freight. But even this is by no means a full measure of the economic disadvantage of exporting the raw material, for the ore contains only 50 per cent. of the metal, each ton of which therefore has to pay the freight on two tons; and, further, as in the process of manufacturing ferro-manganese there is a heavy loss of the metal in the slag and "fume," amounting possibly to 25 per cent., the whole of the tax falls on about three-quarters of the one ton.

So long as we are certain that India possesses more manganese ore than it wants, or ever will want, it is better to export the material for small profits than to allow it to lie idle in the ground. Even if one were certain that India in the distant future would be compelled to import manganese to meet the requirements of its steel industry, it might still be advisable to obtain as a certainty present profits, instead of allowing so much capital to lie idle. But within the next twenty or thirty years, when the richer visible deposits have been depleted, and the manganese miner has "picked the eyes out of the country," the question of exporting ore for the absurdly small rate of compensation now received will become a serious problem for the Government to face, whether it is free to exercise its worldly wisdom in the interests of India itself, or is drilled by Whitehall to conform to the fiscal policy of the party for the time being in power.

The next lesson of importance to draw from the general survey of production is the dangerous state of simplicity in the Indian mineral industries. In every economic system, as in every department of Nature, a simple system is always one which is in a condition of unstable equilibrium, easily upset on the slightest change in the balance of forces. For instance, a rise in the unit-price of manganese to a shilling yields profits to the Indian miner altogether out of proportion to the capital and risks involved, while a fall to eightpence would practically wipe out the whole industry of manganese-mining. Until metallurgical and chemical industries are developed in India, and as long as ores can be raised for export in the raw state, this dangerous state of uncertainty must exist, making it practically impossible to develop any minerals so situated that they can be exploited only by systematic operations incurring a considerable capital outlay. So long, therefore, as these unsatisfactory features of the industry persist, most of the so-called ore-mining in India must be limited to the mere quarrying of the easily accessible and visible deposits of grades sufficiently high to pay for the heavy charges of transport to distant markets. Such an industry, like the vegetation of a desert, is either in a state of rank and luxuriant growth during a favourable season, or is absolutely dead. The weak spot which is so conspicuous in Indian mining is similar in character to that of its agriculture, which depends still almost wholly on the monsoon and the natural fertility of the soil —years of prosperity alternating with years of famine, both being embarrassing, because practically the whole country is affected at the same time and in the same way.

The steadying influence of complexity in the mineral industries will not be possible until the requirements of the country include sufficiently large local markets for the various metals and for the smaller bye-products obtained during their exploitation. The trade returns show that these essential conditions are now gradually ripening, for the imports of metals, and mineral products have been gradually increasing. In 1909 the value of simple metals imported into India amounted to 8½ millions sterling. If we add to this the value of articles made from metals (which naturally cost more than the metals of which they are composed), we obtain a total of over 20 millions. In addition to the importation of metals, there is a large and growing trade in European inorganic chemicals and other mineral products, including sulphuric acid, soda and alum, amounting in value to over half a million sterling, in addition to artificial dyes of about the same value. Precious stones, building materials, and salt together add about another 1½ millions to the annual import bill. I have so far kept out of this statement the two substances, coal and petroleum, which are now being displaced by indigenous products. The imports of coal have been reduced to a small and fairly constant charge for special kinds only, having a total value of about half a

million, while the purchase of foreign mineral-oil has also been reduced during the past ten years from over 2½ to about 2 millions, the Indian consumption having risen at the same time in addition to a small export of kerosene and paraffin-wax from Assam and Burma.

Before the development of some metalliferous minerals can be successful there is, however, another condition, besides a large total market for the chief products, which must be satisfied. Metallurgical and chemical industries are essentially gregarious in their habits; they can flourish only in family groups large enough to utilise one another's subsidiary products, and each family group can survive only when there is a market for the smallest of its members, thus necessitating possibly a very large market for the principal products.

India at one time manufactured its own metals and inorganic chemicals; but, with the opening of the Suez Canal and with concurrent improvements in marine engineering, freight charges from Europe became so reduced that the European manufacturing chemist could "dump" his bye-products at Indian ports, and from there our growing network of railways has enabled the importer, either to kill the native industries altogether, or to drive them back to remote parts of the country.

In addition to the advantage gained by the economical recovery of bye-products, the European chemist has discovered among his inorganic chemicals agencies that do work precisely similar to that of the multitude of low forms of organisms which have hitherto given well-governed tropical countries a natural advantage in the growth of many products. There are certain so-called catalytic agents, such as platinum, ferric oxide, and copper chloride, which act as brokers in a chemical manufactory; they bring together elements to form commercially valuable compounds, which could otherwise only be made by the expenditure of costly energy comparable to that which we have in the great vital energy of the tropics. Unlike the ordinary middleman, these chemical agents work without commission. The unions temporarily so formed by catalytic agents are essentially analogous to the products of the short-lived organisms of the soil, and the manufacturing chemist has thus turned to commercial account in his attack on tropical products what has been aptly termed the chemically loose habits of his reagents.

He has, moreover, recently added another weapon to his arsenal by turning water-power into electric energy; and, as a consequence of all these developments of science, we find that natural products growing wild in the tropics are being displaced, even in their own homes, by material manufactured in Europe, where chemistry has overcome the disadvantages of climate. Two striking examples are sufficient to show this strange reversal of trade. Indian imports of refined sugar from the continent of Europe are now valued at nearly a million sterling per annum. Ten years ago India exported indigo to the value of 1¼ millions; by 1909 the exports of indigo had dwindled down to just one quarter of this value.

The conclusion to be drawn from these alarming facts ought to be, however, reassuring; for what science can do in Europe with climatic drawbacks, it should be able to do with the assistance of tropical advantages. But the statesman who realises this conclusion must realise also that, while the principles of science are the same all the world over, the methods by which they are applied in Europe are not those that will be successful under tropical conditions, and their modification to suit the special conditions of India can be discovered only by research in India itself, with Indian natural products tried under Indian conditions. In the recent cry for the application of technical science to India, it has often been forgotten that methods and men suitable to Europe are not necessarily suitable to India; it has been forgotten that Indian students sent for training in Europe must return with the handicap of a false impression; it has been forgotten that the discovery of special methods suited to the conditions of the country, and the development of new habits among workers do not follow suddenly from the issue of a Government order, nor are they effected in a single generation. Nothing could so strikingly demonstrate the imperfections of our system of education by copybook headings as the recent advocacy by educated Indians of resolutions against the purchase and use of foreign goods. Among the advocates of the "boycott" have been men who are capable of handling as experts the jargon of political economy, but who are so far ignorant of their practical effects as to overlook the fundamental fact that trade, like a galvanic current, requires an unbroken circuit; favourable freight rates for export from India are obtainable only because of the ships being employed also for imports; and every effective demonstration against foreign goods, therefore, merely adds another handicap to the native producer of raw material.

The Principal Minerals.

In selecting special minerals for consideration, I will confine myself to a few prominent examples in each of the two great classes—those that have been rapidly developed, and those that have been neglected altogether. The lessons obtained in both cases are complementary.

Of the minerals for which we have regular and fairly accurate returns, the order of annual value is :—Coal, gold, petroleum, manganese ore, salt, saltpetre, mica, jadestone, ruby, iron ore, graphite, tin ore, chromite, diamonds, magnesite and amber. Unfortunately, we have no statistics by which to measure the production and consumption of building materials, although an annual estimate of these would give even a more faithful curve of industrial progress than the census of the population. In ordinary and ornamental building stone India, and especially Peninsular India, is remarkably well endowed. It is to the abundance and excellence of ornamental building stone as much as to the genius of the people that every ruling dynasty before the advent of the British owed its fame for architectural monuments. Until Lord Curzon scattered some germs of artistic taste, British official buildings in India were constructed mainly of brick, and in a style that has yet to receive a name in the literature of architecture.

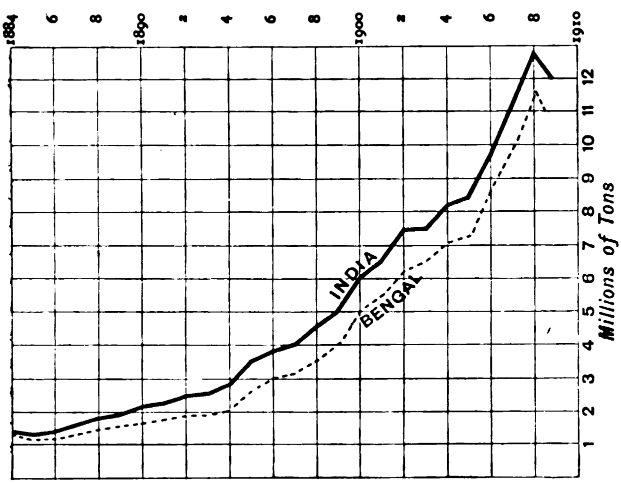

Fig. 3.—Annual Output of Coal since 1884, showing the Share Contributed by the Bengal Coal-fields.

Of the remaining mineral products, coal, petroleum, salt, and iron ore are the most important, because they are consumed in the country and thus contribute to progress in other directions beside simple mining. I propose to consider these four minerals in the first instance, and then to discuss the most important among those raised for export.

Coal.

The production of coal has risen during the past twenty-five years from 1½ millions to just 12 million tons a year. Each year, except the last, has shown an increase on its predecessor, while in 1906 and 1907 there was a sudden rise in production. As usual with all forms of industrial and financial inflammation, known familiarly as "booms," this excess was followed by a setback, and in 1909, for the first time, the upward trend of the curve became interrupted. The production for 1909, however, exceeded that for 1907, and probably represents a figure closely approaching a point lying on the curve of healthy development. From this point we may expect the rise to continue with the general expansion of coal-consuming industries, the workers as well as the share manipulators having received a lesson which will be appreciated for the few years over which the public memory usually lasts.

The only coal of value in Peninsular India occurs in the lower division of the great system of freshwater deposits known as the Gondwana system. These Lower Gondwana beds are divided into two series—Talchir and Damuda The Talchir, or basement, series of the Gondwanas contain no workable coal. The coal-bearing Damuda series is divided, in the eastern coal-fields, into three stages as follows :—

1. Barakar stage.
2. Ironstone shales.
3. Raniganj stage.

The middle stage has been worked in the Raniganj field by the Bengal Iron and Steel Company, who have now nearly used up in their blast furnaces at Barakar the visible supply of clay-ironstone. The other two stages are the chief sources of coal, the older, or Barakar stage, being the more important in the Giridih and Jherria fields, while both have been freely worked in the Raniganj field.

About the best coal in the peninsula is that obtained from the lowest seam worked by the East Indian Railway Company in the Giridih field, where the coal sometimes shows on assay under 6 per cent. of ash and has a calorific value

of about 8,000 units. According to an estimate made by Dr. W. Saise in 1894,* the Giridih field then contained 82½ million tons of available coal, and of this nearly 12 million tons have since been produced, leaving little over 70 million tons as roughly the amount still obtainable.

Numerous assays have been made of the samples taken from the seams being worked in the Jherria and Raniganj fields. Probably the results which most fairly represent the nature of the coals being marketed are those obtained by Major F. C. Hughes, of the Calcutta Mint.† These figures confirm previous results‡ in indicating that the coal in the lowermost Barakars differs from that in the Raniganj stage in containing less moisture and less volatile hydrocarbons, with a proportionately higher percentage of fixed carbon. There is a similar difference, less in degree, between the lower and upper seams in the Raniganj stage. The following table shows the average results which I have worked out from the figures published by Major Hughes:—

	Moisture.	Ash.	Volatile Matter.	Fixed Carbon.	Calorific Value.	
					Calculated.	Determined.
Raniganj (24 samples) .	4·50	9·73	32·03	53·74	6864	6828
Barakar (31 samples) .	1·22	11·04	23·76	63·98	7536	7331

developed. In these areas the percentage of moisture is generally as high as 12, with about the same percentage of ash, and thus nearly a quarter of the coal reduces instead of increases its calorific value. The calorific value of coals of this class from the Central Provinces will generally range around 6,000 units, as against 7,500 for Bengal coals from the Barakar stage, and about 6,900 for the Raniganj stage. No explanation has been offered for this extraordinary percentage of moisture in the coals south of the Satpura Range; no indication, therefore, can be given as to the prospects of the coal improving in this respect at greater depths.

The coal being worked in the Mohpani field at the northern foot of the Satpura Range in the Central Provinces conforms more nearly to the Raniganj type of the Bengal coal-fields in having only from about 2 to 5 per cent. of moisture; and, in spite of the slightly higher percentage of ash, the Mohpani coals show on an average a slightly higher calorific value than is obtained for the seams exposed to the south of the Satpura Range. Most of the coals in these fields are either non-coking, or, at best, produce a poor, friable coal. They, however, find a ready market for steam purposes among the cotton presses and factories of the Central and United Provinces.

In thirty-one samples of Barakar coals the volatile hydrocarbons amounted on an average to 27 per cent. of the total combustible constituents, while in twenty-four samples of coals from the Raniganj stage this percentage is found to be about 37.

In the Central Provinces, coal, of the same age as that worked in Bengal, contains an extraordinary amount of moisture, which seriously depreciates its calorific value. A very high percentage of moisture was shown by all the coals from the old colliery at Warora, which was abandoned in 1906; in the new field now being opened up at Bellarpur in the Chanda district, and in the Pench Valley field of the Chhindwara district, which is being rapidly developed.

It is certain that the Pench Valley field especially will develop at a much more rapid rate when the field is crossed by a broad-gauge rail connection between Nagpur and Itarsi. At present the only railway outlet for the field is by a narrow-gauge line, which reaches the two great broad-gauge systems—the Bengal Nagpur on the south and the Great Indian Peninsular on the north—by the longest route possible. To transport coal from Chhindwara to the factories of Nagpur by rail necessitates a journey of 184 miles on a narrow and 80 miles on a broad-gauge line, involving obviously a rehandling of the coal in the middle of the journey. In the same way, transport from the Chhindwara field to any of the large towns on

* *Records, Geological Survey of India*, Vol. XXVII., 86, 1894.

† "Proximate Analyses and Calorific Values of Bengal Coals." *Transactions of the Mining and Geological Institute of India*, Vol. V., 114, 1910.

‡ *Cf.* Holland. "Sketch of the Mineral Resources of India," 1908, p. 13; *Imperial Gazetteer*, III., 1907, p. 133.

the northern system of broad-gauge railway involves 180 miles of narrow-gauge, with a rehandling of the coal at Jubbulpore. A through broad-gauge line from Nagpur to Itarsi would bring the field within about seventy miles either of the great consuming centre of Nagpur, or of the main junction for the still larger markets in the north-west, and the change of gauge would thus be avoided. As this route will tap also a rich cotton-producing country, as well as the principal manganese mines, and will connect the capital of the Province with the great trade route of the north-west, the delay in its construction indicates a policy in railway development that cannot at any rate be regarded as over-enterprising.

By far the largest fraction of Indian coal is obtained from these Gondwana fields in the peninsula, the percentage contribution to the total output having risen gradually during the past ten years from about 93 to a little under 97 per cent. Most of the increase is due to activity in the two fields nearest Calcutta, Raniganj and Jherria. The Raniganj field up to fifteen years ago was the premier field; but, as soon as railway extensions were pushed into the Jherria field, the latter became rapidly opened up, its production having increased by over six times during the past ten years, and now amounting to about half the Indian total, while Raniganj contributes just one-third of the total. The remarkable development of Jherria immediately after the introduction of the railways offers a good illustration of the direct relationship between railway enterprise and industry.

In extra-peninsular areas, that is, in Baluchistan, the Punjab, Assam and Burma, the coal raised is almost entirely of Tertiary age. These coals, on the whole, differ from the Gondwana coals in containing a larger proportion of volatile hydrocarbons, though they vary greatly in composition and in thickness of seam. The deposits most largely worked are those of north-east Assam, where the coal occurs in seams of great thickness, with a remarkably low percentage of ash and a high calorific value. The composition and quality of these coals have been discussed by Professor W. R. Dunstan in a paper read before this Society in 1902.*

The quality of the coal obtainable from north-east Assam is shown by the following assays of samples more recently obtained by Mr. R. R. Simpson, from the collieries being worked near Margherita by the Assam Railway and Trading Company:—

	Upper Ledo.*	Tikak.†
Moisture	1·80	2·09
Volatile Hydrocarbons .	40·15	37·25
Fixed Carbon	55·59	58·99
Ash	2·46	1·67
Total	100·00	100·00

The development of the thick seams of high quality in this field is limited by the market, which locally includes the comparatively small wants of the tea-gardens, railways, and the steamers on the Brahmaputra. Expense of transport cuts off the large market of Calcutta, and though the coal itself, which is friable and liable to spontaneous combustion, is not easily carried for long distances, the perfect coke which it yields would be valuable with lower freights. The annual production of this field remains steadily at about 280,000 tons, while the total annual output of all the Tertiary fields in Extra-Peninsular India is only about 400,000 tons.

Colliery Labour.

Beside the mere financial and commercial results obtained, it is important to criticise the mining industry in its bearing on the well-being of the 120,000 persons employed at the collieries, as well as the larger number of their dependents.

During the past ten years the average number of deaths from colliery accidents in India has been 95 per annum, or at the rate of only 0·93 per thousand persons employed at the collieries. This figure compares favourably with the corresponding results for coal-mining in other countries. For the whole of the British Empire the death-rate from accidents at coal-mines ranges around 1·4 per thousand persons employed; while in the United Kingdom alone, where the labour statistics are sufficiently large to control the average for the whole Empire, the death-rate from colliery accidents has remained steadily, for the last few years, near 1·3 per thousand, a rate which has been exceeded during one year only in India, namely in 1908, when a serious accident in the colliery owned by

* *Journal of the Royal Society of Arts*, Vol. L., pp. 371-407.

* Average of three samples representing an aggregate thickness of forty-nine feet.

† Average of five samples representing an aggregate thickness of forty-seven feet.

TABLE III.

LABOUR STATISTICS AT INDIAN COLLIERIES.

Year.	Number employed daily.	Tons of Coal raised per person.	Deaths from Colliery Accidents.	Deaths per 1,000 Persons Employed.
1900	89,248	69	*62*	0·69
1901	95,318	70	*70*	0·73
1902	98,312	75	*76*	0·77
1903	88,530	84	*97*	1·10
1904	92,740	89	*67*	0·72
1905	89,995	93	*72*	0·80
1906	99,138	99	*99*	0·99
1907	112,502	99	*101*	0·89
1908	129,173	99	*178*	1·37
1909	119,546	99	*128*	1·07
Average	*101,450*	*89*	95	*0·93*

one of the State railways at Khost in Baluchistan had a disturbing effect on the average.

The Indian figures compare still more favourably with statistics for foreign countries. In 1907 the average for all non-British coal-mining countries was 2·97 deaths per thousand persons employed, and in 1908 the corresponding figure was 2·34. The principal contributor to the higher death-rate in foreign countries is always the United States, where nearly 3,000 colliers are killed every year, with a death-rate always over three per thousand persons employed.

The remarkable safety of Indian mines almost removes the occupation of the collier from the class of "dangerous" occupations, the death-rate from accidents being lower than that at any class of mines, or even at quarries, in this country. To a large extent the satisfactory figures are due to certain natural advantages in the principal coal-fields of Bengal, where the majority of the workers are employed. In these fields there is such a general freedom from gas that only in a few mines are safety-lamps considered to be necessary, while the coal-bearing strata are so little disturbed by earth-movements that a natural roof can be relied on without timber in most galleries, even in those of much wider span than the galleries commonly worked in England. The mines are comparatively shallow, no shaft at present being more than 900 feet in depth; consequently, there is a small overburden to be maintained, and less danger from the "creep" due to earth pressures.

I think also that every coal-mine manager in India, who has had his training in the United Kingdom, will admit that the satisfactory state of affairs in Bengal is partly due to the careful habits of the collier himself, who, in spite of his ignorance of the principles which govern safe mining operations, retains so far a sense of discipline that has now been all but destroyed by our education authorities in this country. Nevertheless, there are indications that in India also the increased complexity of operations, which naturally follows the deepening of the mines and general extension of the workings, is adding to the dangers to which the collier is exposed. The annual rates for the last ten years range between 0·69 and 1·37 deaths per thousand persons employed; the lowest rate being in 1900 and the highest in 1908, while during the last five years the death-rate has averaged a little over 1·0 per thousand employed. It is possible that the higher rate during the past few years is a purely fortuitous agreement with our expectations from a knowledge of the gradually-increasing difficulties of mining, for with totals so small a serious accident, like that which occurred at the Khost mines in June, 1908, makes a notable mark on the record for the year. This accident having occurred in a Government mine, those prophetic critics who anticipated disasters as the result of the feverish

haste in raising coal to meet the "boom" of 1907 cannot point to the statistics as a certain fulfilment of their expectations. One must admit, however, that although haste in mining may not reveal itself at once in the labour statistics, for many years following the effects may result in loss of both men and material.

The statistics for mines under the control of the Government inspectors, who administer the Indian Mines Act of 1901, compare favourably with those in the Native States. During the past five years the death-rate from colliery accidents in Native States has averaged 1·4 per thousand persons employed, against an average of 1·0 during the same period for mines in British India. Before drawing any inference from these figures it is necessary to remember that the largest employer of labour among collieries in the Native States, namely, the Hyderabad (Deccan) Company, works its collieries in an area geologically more disturbed than the Bengal coal-fields, while the work in the Bikanir State of Rajputana, although on a scale too small to disturb the averages, is also carried on under unfavourable natural conditions. The average death-rate for the Singareni colleries in Hyderabad has been 1·55 per thousand for the past five years, a comparatively high figure, which is partly counterbalanced by the remarkably low rate of only 0·35 per thousand at the Umaria collieries in the Gwalior State of Central India. The unfavourable figures for Native States are thus due mainly to the returns from Hyderabad, where, as I have already explained, mining conditions are less simple than in Bengal.

A much more serious problem than that of ordinary mining accidents is due to the changes in population around the coal-fields, where the workers and their families, mostly derived from aboriginal tribes accustomed to the free life of the sparsely-populated jungle, are being crowded together, with an environment to which they are accommodating themselves by considerable loss of life. The simplicity of the lives and habits of these peoples, like that which I have already referred to as the nature of our mineral industries generally, lends itself to manifest dangers, and the growth of the coal-mining industry has been so rapid in the two principal fields that the colliery owners have been unable to make sufficient provision to prevent dangers which they now realise as financially serious. The questions of sanitation and water-supply have been forced recently on the colliery owners by serious cholera epidemics, and a concerted move for reform is now being actively organised, mainly through the public-spirited action of Mr. R. P. Ashton, of Messrs. Kilburn & Co., whose presidential address to the Mining and Geological Institute at Calcutta in January last deals very sympathetically with this serious problem. The recent halt in the rapid progress of Indian coal-mining has given the owner time to review his methods of work, and the result will be increased economy in handling his possessions of saleable mineral, as well as more thought for the health and happiness of his miners. Everyone, however, who has had experience of both countries, will admit that the average Indian collier is a far happier individual than his caste-fellow in England.

Coal Consumption.

The coal-consuming industries may be considered in two divisions, namely, the railways in one, and all other forms of coal-consumers in the other. Up to about ten years ago a serious fraction of the coal consumed on Indian railways was imported; from that time onwards foreign coal has generally varied between only 1 and 2 per cent. of the total supplies. The ratio, therefore, between the consumption by railways and the consumption by various industries in India forms roughly an index to the industrial expansion generally. During the past ten years, although the production of coal has been doubled, there has been a very steady and constant relationship between these two forms of consumption.

From Table IV. it will be seen that the railways have taken very nearly 30 per cent. of the total Indian output, and that the variation has been confined within the very narrow limits of 28·2 to 31·7 per cent. The remarkable constancy in this proportion, in spite of the great change in the total, at first sight seems to be inexplicable; but, so far as I can see, there is one simple lesson to be learnt from this interesting result, namely, that the industrial expansion of India is directly dependent on, and limited by, the railway expansion. The first conclusion drawn from these facts shows that the Government policy with regard to railways has, at any rate, followed safe lines; whether the policy has been, on the whole, unnecessarily conservative is another question. There is an interesting record of correspondence in the Geological Survey Office at Calcutta, between one of my predecessors and the Government of India in the late fifties. The Director of the Geological Survey urged on Government the extension of the East Indian Railway to the northern parts of the Raniganj coal-field; and

TABLE IV.

COAL CONSUMED ON THE INDIAN RAILWAYS.

Year.	Indian Coal.			Foreign Coal.		Total Consumption.
	Quantity.	Per Cent of Total.	Per Cent. of Indian Output.	Quantity.	Per Cent. of Total.	
	Tons.			Tons.		Tons.
1900	1,855,610	97·2	*30·3*	54,339	2·8	*1,909,949*
1901	1,956,601	99·3	*29·5*	13,248	0·7	*1,969,849*
1902	2,091,992	99·0	*28·2*	21,469	1·0	*2,113,461*
1903	2,203,889	99·2	*29·6*	17,696	0·8	*2,221,585*
1904	2,447,341	99·3	*29·8*	17,432	0·7	*2,464,773*
1905	2,668,424	99·3	*31·7*	18,235	0·7	*2,686,659*
1906	2,878,281	98·7	*29·4*	37,280	1·3	*2,915,561*
1907	3,343,219	98·4	*29·9*	54,861	1·6	*3,398,080*
1908	3,604,094	97·9	*28·2*	79,633	2·1	*3,683,727*
1909	3,689,093	98·0	*31·0*	76,221	2·0	*3,765,314*
Average	2,673,854	98·63	*29·76*	39,041	1·37	*2,712,896*

in his attempt to produce an impression on Government, his enthusiasm led him to believe that it would pay in the long run to push the railway north-westwards even as far as Benares! At that time the East Indian Railway extended for 120 miles from Howrah to Raniganj, while the Great Indian Peninsular Railway joined Bombay to Thana, a distance of 21 miles, both these short lines being regarded as experimental innovations, preparing the way for the greater policy outlined by the far-seeing statesmanship of Lord Dalhousie, to whose minute, written in 1853, we can trace the policy of constructing the great trunk lines to connect the Presidency capitals. It is, perhaps, easy for anyone with special and local knowledge to point to instances in which the Government policy has been unnecessarily cautious; so far as the coal trade goes, one can say with fair safety that, at any rate, there is no indication of Government having erred on the side of reckless enterprise; for, as I have pointed out, the percentage of coal consumed on the railways as an index of industrial expansion has remained perfectly steady.

The yearly variations in the figures for imports of foreign coal, and exports of Indian coal, have been too limited to have any great significance. One change, however, has occurred which is noteworthy, for it coincides with the general utilisation of Indian coal on the railways since ten years ago. Up to the financial year 1899–1900 the imports of foreign coal exceeded

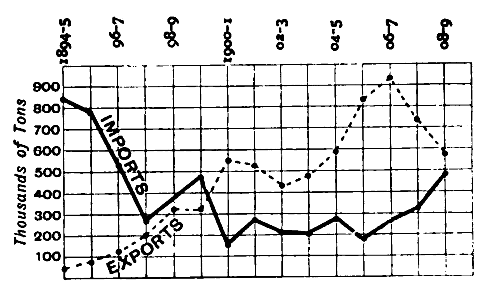

FIG. 4.

ANNUAL IMPORTS OF FOREIGN, AND EXPORTS OF INDIAN, COAL FOR FIFTEEN YEARS.

the exports of Indian coal; in the following year the relationship was reversed, and since then the imports have been generally limited to small quantities to meet local and temporary variations in the demand for special coals, while the exports have on an average been over half a million tons per annum, with a slight tendency towards increase during the last few years. The available foreign markets for Indian coal are, however, comparatively small, for the principal consumption around the Indian Ocean, within

striking distance of the country, is due mainly to locomotive wants.

Petroleum.

The development of petroleum, like that of coal, has given results that ought to satisfy the most exacting political economist. Practically the whole of the crude material is converted on the spot into refined products, and thus, whether consumed in the country or exported, is turned to full account. The growth of the petroleum industry forms one of the most interesting chapters in the development of Indian minerals.

The belt of Tertiary rocks forming a great arc stretching from the north-west corner of the Himalaya, through Baluchistan and Persia, to the famous fields of south-east Russia, show signs of oil at various places. A series of folds approximately similar in age stretches away in arc-like fashion from the eastern end of the Himalayan belt, with a general southerly trend through Assam and Burma, to the oil-bearing Tertiary rocks of Sumatra, Java, and Borneo.

In spite of the numerous "shows" of oil in Baluchistan and the Punjab, no serious or continuous exploitation has been so far accomplished in this part of the Indo-Iranian oil-bearing arc. In the Assam and Burma section of the eastern arc oil has been developed within a small area in the north-east corner of Assam, where the annual output has ranged around three million gallons for some years, and in Upper Burma, where the development has been limited practically to three fields, known as the Yenangyat field in the Pakokku district, the Singu field further south in the Myingan district, and the Yenangyaung field along the same line of folds in the Magwe district. Of these three, the Yenangyaung field, which has been exploited for many generations by native well-diggers, has always been, and still is, the most productive.

The development of the Yenangyat field began on a serious scale no further back than 1891, through the enterprise of the Burma Oil Company. The output rose slowly till 1894, and thereafter more rapidly until it reached a maximum of 22½ million gallons in 1903. From that year it has steadily declined to an output of a little over 6 million gallons in 1909.

The Singu field sprang into prominence in 1902, reaching an output of over 5½ million gallons in the following year, with a still more rapid rise to 23½ millions in 1904, and since then to a maximum of 43½ millions in 1907. The output of this field still exceeded 43 million gallons in 1908, but dropped to 37 millions in 1909. The diminished production during this last year is not, however, a reliable indication of failing resources; for the companies concerned have, by force of competition, devoted their main energies to the small but exceedingly rich area originally reserved by Government for the benefit of the native well-diggers in Yenangyaung.

This small section of the Yenangyaung field, known as the Twingon Reserve, has yielded the principal fraction of the field's output, which has risen during the past twenty years from under 10 to over 187 million gallons of crude oil. The operations in this field from an economic point of view are of such an interesting kind that they merit more detailed consideration.

For many years before the annexation of Upper Burma in 1885 the sole right to dig for oil in the Yenangyaung field was vested in twenty-four persons known as *twinzayos*, this right, or as it was called, the *ayo*, being hereditary. Each *twinzayo*, however, had the power to sell his *ayo* with the consent of the other twenty-three members of the guild. He or she—for the *ayo* sometimes descended through the female line—had the power to allot sites for oil-digging, each site extending to a distance of about 60 feet from the edge of the well in all directions. The *twinzayos* as well as the *twinzas*, or native well-diggers to whom sites had been allotted or sold, were obliged to sell all oil extracted at a fixed price, well below its market value, to the King's contractor. On taking over Upper Burma the Government of India recognised the hereditary rights of the *twinzayos*, and they permitted the *twinzas* to sell their oil in the open market, as well as to alienate their digging rights to whom they pleased, the Government taking a fixed royalty equivalent to eightpence for every forty gallons of crude oil extracted. In place of the old ill-defined practice of granting further well-sites to the *twinzayos*, the Government demarcated two reserves in what was apparently the rich parts of the field, and within these reserves each *twinzayo* was granted annually a regular number of well-sites. According to the "Executive Instructions" sanctioned in 1893, these sites were not to exceed one-fifth of an acre in area; but, in applying the sanctioned rules, a local custom arose, or rather was continued from the pre-British days, of requiring only an interval of 60 feet between the centres of the sites. As a consequence, the sites granted were about one-fourteenth, instead of one-fifth of an acre, and in this way the whole of the land available for oil-winning in the reserves became divided into thousands of small sites.

The *twinsa*, with his hand-dug well, can exploit only the shallow oil-sands; even with the assistance of a diver's equipment introduced in late years, his operations do not extend below 300–400 feet. As, however, there is nothing in his grant to prevent the site being sold for any purpose and to any person, the purchase of sites by the Burma Oil Company for deep drilling opened in 1896 a new chapter in the history of the fields.

in value to as much as £3,000 and £4,000. As the wells drilled proved to be so uniformly successful in the central and southern part of the Twingon Reserve, a veritable forest of derricks began to arise. In consequence of the small area of the individual sites, with American drillers exploiting the deep and gassy sands, while the *twinzas* between the derricks continued modestly to bail out oil from the upper beds, serious risks of fire were incurred.

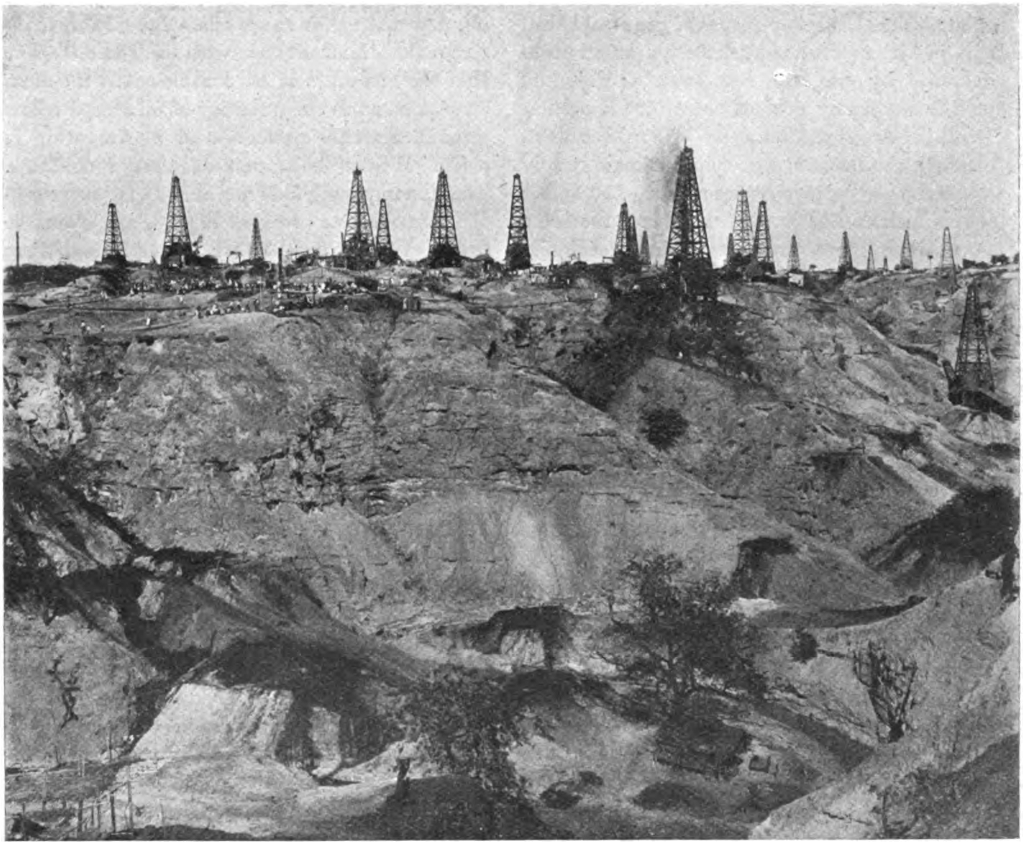

Fig. 5.—Yenangyaung Oil-field, Upper Burma.

View of Twingon Reserve from Khodaung, showing gushing well and, in the foreground, a characteristic deep gorge with some native hand-dug wells of the Twinzas.

Photograph reproduced by permission of the Burma Oil Company.

With the threatened intrusion of competing companies ten years ago the market price of well-sites within the reserves rose rapidly from under about £7 to about £200. At the end of 1906 the Rangoon Oil Company, which had been previously working in the Yenangyat field, also secured leases of well-sites in the reserves from the *twinzas*. The success which followed their operations tempted other companies, with the result that sites in the richest areas rose rapidly

In consequence of the feverish haste with which the competing companies rushed for the richer oil-sands, there was the danger of imperfect precautions being taken to keep the subterranean water out of the productive oil-sands, while possibly there was some danger also of imperfect exploitation of the resources.

In 1908 the Government appointed a Committee to make a careful investigation of the complicated circumstances which had arisen in

consequence of this alienation by the *twinzas* of small well-sites to European companies for drilling. The Committee found that there was, as anticipated, a serious danger of fire, due to the congestion of derricks with free-flowing wells of gassy oil interspersed among the native hand-dug wells. The new state of affairs had developed so rapidly that there were no regulations framed, either by Government or by the companies themselves, for the purpose of safeguarding the valuable field. The Committee found also that, in consequence of the established right of the *twinza* to alienate his small well-sites, site by site, no new system of tenure could be equitably devised to enforce a greater interval between producing wells than sixty feet. Although the *twinzas* were selling sites formerly regarded as expensive at from £5 to £10 apiece for as much as £4,000, and were thus receiving many times more than the values originally contemplated when the system of tenure was sanctioned, it would obviously be inequitable to adopt any new system which would depreciate even slightly or temporarily the market value of the sites. Similarly, it was found to be impossible to rearrange the holdings of the European companies, by exchange of sites for the purpose of forming larger blocks, as there were no data by which to form any idea of the great local variations in the values of different parts of the field.

The Committee consequently were forced to propose a series of regulations to mitigate, so far as possible, the dangers due to a confessedly unfortunate system of granting small holdings. The proposals made, after criticism by the companies and *twinzas*, were embodied in a Regulation passed last year by the Legislative Council of Burma. According to this Regulation, known as the Upper Burma Oil Fields Regulation of 1910, the field is placed under the control of a Warden, who has the power of a Magistrate of the first class, and is deemed a Revenue officer within the meaning of the Upper Burma Land and Revenue Regulation of 1889. Consistent with the new Regulation, detailed rules are issued defining the powers of the Warden, describing the manner in which well-sites are to be demarcated, the manner in which hand-dug wells are to be protected, the nature of regulations regarding the access of persons not employed in the work of oil-winning, the methods for measuring the oil produced, the precautions to be taken for the prevention and extinction of fires, the precautions to be observed to prevent the flooding of oil-sands by water, and regulating rights of way and transport. The new Regulation in many ways adds to the cost of oil-winning, but it has been recognised by the oil companies as a desirable form of insurance.

It is impossible ever to predict the trend of development in an oil-field, for there is absolutely no way by which an estimate can be made of the total resources of any field. The geologist is able to recognise certain stratigraphical features that are *favourable* for the storage of oil, but there are more fields favourably constructed without oil than with it. The mere fact that the structure is favourable gives no more exact idea as to the quantity of oil stored below ground, than the perfection of workmanship in a safe indicates the amount of money it contains. The Yenangyaung field has already far surpassed the expectations of every expert, and even the hopes of every speculator; nevertheless, there must be a limit to the quantity of oil available for exploitation, and no one has a right to expect that the heavy drain now occurring within a few acres in the centre of the field can last for many more years. Signs of exhaustion have appeared already in the upper oil-sands, and the drills are now seeking new reservoirs at greater depths. No one knows when the inevitable end will appear, and, unless other productive fields be discovered, the collapse of the Burma oil industry will be described more accurately as sudden than rapid. The Yenangyat field, which gave rise to great hopes ten years ago, has proved to be most refractory. On account of its topographical features, it is an expensive field to work, and the topographical features being partially an expression of complicated structure below, it is difficult to locate wells in it with any assurance of success. Singu is certainly capable of a greater output than the production figures show, and it must be regarded partly as a reserve to tone off the rapid fall which will otherwise follow the exhaustion of the Twingon Reserve in the Yenangyaung field. The rest of Burma may be summed up in one sentence: there are numerous occurrences of rocks similar in age to those which are productive in the three principal fields; in many cases these show a suitable stratigraphical structure for oil-storage, but so far not one among them has paid the expenditure incurred in prospecting.

The only area, in addition to Singu, that can now be looked upon as a satisfactory reserve is that known as the Khodaung tract in the Yenangyaung field. In structure the Khodaung is a replica of the rich

Twingon Reserve; it is, in fact, the other half of the dome, whose summit is very near the dividing line between the Twingon Reserve on the north, in which so many companies and *twinzas* are scrambling for a share of the oil, and the Khodaung to the south, which is held by the Burma Oil Company.

In this area (the Khodaung) the Burma Oil Company has wisely limited its drilling operations in depth, and has placed the wells sufficiently far apart to prevent, so far as can be judged, mutual interference. It is probable, almost certain in fact, that some of the oil being drained off from near the southern border of the Twingon Reserve comes across underground from the Khodaung area, and to this extent the property held by the Burma Oil Company is being depleted by their competitors near the boundary line. To what extent this depletion is serious has yet to be proved. By a careful comparison of the large number of well records in the field, the Committee of 1908 found that there was a great variation in the radius from which a well might draw its supplies of oil. Wells separated by less than 100 feet sometimes appear to be quite independent of one another. In other cases a new well put down several hundred feet from an old producer has been found to have a marked effect on the older well. The results of our local investigation coincide with conclusions from purely theoretical considerations: the sandbanks in which the crude oil is stored underground are not continuous sheets, but, as anyone might infer from the conditions under which sandbanks are formed, they are lenticular patches of sand separated by partial or complete envelopes of impervious clay; thus, two wells, separated by a short interval, may be tapping the edges of two adjacent, but distinct, sandbanks; on the other hand, one of these wells might be near the edge of the same sandbank as a third well several hundred feet away. In addition to this original disposition of the oil-bearing strata, adjoining wells may tap the same sandbank and yet be made independent of one another by a very slight fault of the kind extremely common in all oil-fields.

At great depths, where the oil is under pressure and is more mobile because of its higher temperature and larger content in the lighter hydrocarbons, there is probably a more complete communication between adjoining sandbanks than would be the case at shallower depths, where oil of the kind occurring in Burma suffers from the clogging effect of its high charge of paraffin; consequently, there is reason to suppose that, whatever may be the effect on Khodaung as the result of draining the Twingon Reserve, its effect will be proportionately more serious in the deeper than in the shallower oil-sands. Every oil-driller also recognises what he imagines to be channels of supplies underground; if he can get down his well to a producing sand before his neighbour reaches the same level, he thinks that it is possible to establish channels from the neighbouring parts of the sand towards his own well, and thus he concludes that he will have a permanent advantage over his neighbour. In this conclusion he is probably correct, and it is consequently likely that wells in the southern section of the Twingon Reserve will continue to rob oil from those put down by the Burma Oil Company to the same oil sandbanks in the Khodaung area.

It is doubtful if the summit of the great oil-storage dome, forming the rich part of the Yenangyaung field, lies on the Twingon or on the Khodaung side of the boundary between the native reserve and the Burma Oil Company's property. On the whole, there seems to be some slight balance of evidence in favour of the conclusion that the actual summit is within the Khodaung boundary. Thus, if it were a case of simple competition between one company working the Twingon and the Burma Oil Company working in Khodaung, the latter would have a slight advantage in the race. The competition has, however, been complicated by the circumstance that the Burma Oil Company are also the largest holders, by purchase from the *twinzas*, of sites in the Twingon area, and their policy has been, consequently, to drill at least one well as near as possible to every well put down by the competing companies. They know that the well-sites secured by other companies, though smaller in number, are so distributed throughout the reserve that their own interspersed sites would be largely drained if they did not take a share in the drilling competition. They are thus compelled to witness the drainage of their own property, and are forced to take themselves as large a share as possible in the process.*

* The vigorous action of the Burma Oil Company in the Twingon Reserve was naturally criticised by some of the witnesses examined by me as President of the Oil Committee in 1908. It should be remembered, however, that this Company entered the field before they could reckon on British protection, and it was through their enterprise that the value of the deeper oil-sands was first proved by drilling; they purchased distributed well-sites in the Twingon Reserve before any of the present competing companies were floated, and, on account of the threatened intrusion of a large foreign trust, paid prices at the time largely in excess of the

Those who are producing crude oil only for sale to refineries will regard the exhaustion of the Twingon Reserve as merely the end of their present easily-earned profits; and the capital to be recovered will be the small amount invested in the wells and their accessories. With some other companies, who have laid out large sums on refineries, the prospect is far more serious; for, unless other productive fields be discovered, and discovered at once, there appears to be a slender chance of the debenture-holder being able to realise the full value of his investment. The Burma Oil Company will be able to turn to its reserves in Khodaung (which is probably nearly as rich as Twingon), and to Singu, in

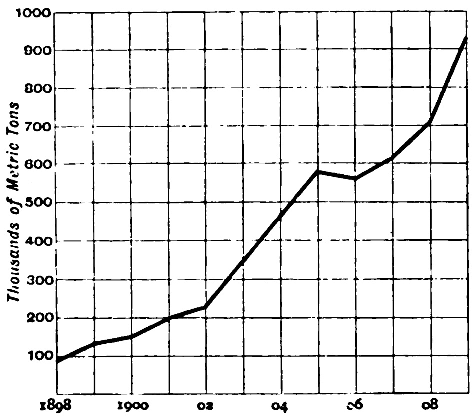

FIG. 6.—ANNUAL PRODUCTION OF CRUDE OIL, 1898–1909.

addition, perhaps, to a reasonable expectation of favourable results at Minbu, on the other side of the Irrawaddi river. I wish it were possible to show that the enterprise of all the other companies who have tied up their capital in expensive refineries had equally good prospects. But, as I have already explained, the existence of similar strata in other districts, and their disposal in structures suitable for the storage of oil, do not necessarily mean the occurrence of the crude material in commercial quantities. A wisely-governed oil company must necessarily keep in hand as a reserve large areas in which prospecting operations indicate good oil-supplies, and as no one can ever estimate the quantity obtainable, every serious outlay of capital must be regarded as speculative until profits are obtained sufficient to cover its amortization. All forms of mining must be accompanied by a considerable number of risks that cannot be accurately estimated, and while it may be necessary to secure a large nominal capital to be ready for possible developments, it seems to me to be an unwarrantable addition to, or rather a multiplication of, the usually great risks of oil-winning to lay out money on refinery plants for the visible output only from an already highly-drained field. In this case the exhaustion of the Twingon Reserve will be a serious loss to all companies, but it will mean absolute extinction to those that have no productive reserves in other districts. There is little doubt that the Twingon Reserve is now showing serious signs of fatigue; flowing wells, when struck, rapidly fall off, and most of the producing wells in the field are now reduced to pumping, with an average daily output of only about forty-five barrels.

The total production of crude oil in India has risen during the past ten years from $37\frac{3}{4}$ million gallons in 1900 to over $233\frac{1}{2}$ million gallons in 1909 (see Table V. and Fig. 6). Although the rise has been rapid and with but one small interruption, the output is still a small fraction, only 1·66 per cent. of the world's total production, which is nearly all due to foreign countries. In considering the question of using petroleum as a fuel, it should be remembered that only a fraction of the total crude output can be safely turned to account, and the total production of India in 1909, though expressed by a large figure in gallons, was not more than about 938,000 tons—that is, less than one-twelfth of the output of coal.

TABLE V.

TOTAL PRODUCTION OF PETROLEUM.

Year.	Quantity.		Value.
	Gallons.	Metric tons.	£
1900	37,729,211	*151,523*	148,755
1901	50,075,117	*201,105*	204,342
1902	56,607,688	*227,340*	217,816
1903	87,859,069	*352,848*	354,365
1904	118,491,382	*475,869*	473,971
1905	144,798,444	*581,520*	604,203
1906	140,553,122	*564,470*	574,238
1907	152,045,677	*610,625*	610,015
1908	176,646,320	*709,423*	702,009
1909	233,678,087	*938,466*	928,658

recognised market prices of well-sites, on which their drilling operations into the deeper oil-sands interfered in no way with the work of the *twinzas*, who worked the shallow sands only.

The indigenous product is insufficient to meet the country's requirements in kerosene and petrol, of which nearly 90 million gallons are still imported annually, to the value of about 2¼ millions sterling. On account of the high percentage of solid hydrocarbons in the Assam and Burma oil, there is a growing output and export trade in paraffin wax, which reached a value of £225,139 in 1909. The exports of kerosene are comparatively small, and are variable, as they merely meet the trade relations for exchange between the Indian companies and those of the Dutch East Indies supplying the Eastern market.

SALT.

Salt, apart from its market value, is among the important minerals, for, in addition to the half a million which it contributes to the annual total of production, it still yields a tax of over three millions sterling. The production of salt in India is, however, a Government monopoly, and thus calls for no comment from the mining investor's point of view. The annual production during the past ten years has been 1,174,329 tons, but there has been an increase in both production and import since the last reduction of the tax in 1907, although a portion of the increased consumption, now just 1¾ million tons per annum, is certainly due to the increased prosperity of the people. The tax has the merit of being shared by everyone, and now amounts to only 2½*d.* per head of the population, with an annual consumption of just 13 lbs.

Of the salt produced in India about 63 per cent. is obtained from sea-water, 26 per cent. is obtained from inland lakes and subsoil water in the dry regions of Rajputana and the Punjab, while the remainder, amounting to 11 per cent., is mined from the thick masses of rock-salt in the Punjab and North-West Frontier Province.

One of the most interesting features in connection with the industry is the discovery recently made by the Geological Survey that the enormous stores of salt accumulated in the desert region of Rajputana have been brought in in the form of fine dust by the hot winds which blow from the S.S.W. over the salt-incrusted arm of the sea in Cutch during the hot months of April to June.* The Government of India thus depend on the dry as well as the wet part of the annual monsoon for an important direct source of revenue. We have proved the existence in the superficial layers of silt under the Sambhar Lake alone of over 54,000,000 tons of accumulated salt, which has all been carried some 500 miles from the sea-coast, and there may be many Sambhars buried under the desert sands.

IRON.

There are two fairly prevalent ideas regarding India from the point of view of iron manufacture :—(1) That India is rich in iron ore ; and (2) that attempts to introduce European methods of smelting have failed in the past and are likely again to lead to failure. The failures referred to, although few in number, have been conspicuous and well advertised. Among them we have the concerns which developed from the initial efforts of Josiah Marshall Heath, who left the service of the East India Company in the early part of the last century in order to satisfy by commercial enterprise his belief in the rich mineral resources of Southern India. At a later date failure followed an attempt to smelt iron in Chota Nagpur, and again at Kaladunghi in Kumaun, where the ruins of furnaces and workshops stand as silent witnesses to misguided effort. Whether all these failures were due to conditions that still exist, or whether they were due, as has often been asserted, to mistakes that might have been avoided, cannot now be determined with certainty ; and any inquiry into their nature is not likely to lead to conclusions sufficiently certain and precise to be of present value. The only attempt to manufacture iron on European lines which has been successful still persists at Barakar, about 130 miles north-west of Calcutta, where success has been limited to the manufacture of pig-iron. For many years even in this area, where the natural conditions seemed to be so eminently favourable, the smelting of iron was unprofitable, and although the present Bengal Iron and Steel Company, since its management was taken over by Messrs. Martin and Company in 1889, has been a commercial success while confining itself to the manufacture of pig-iron, its experimental effort towards steel-making incurred a cost that soon led to its abandonment.

A new attempt is now being made to manufacture both pig-iron and steel on European lines by the Tata Iron and Steel Company, which was floated in August, 1907, with a capital of 1½ millions sterling. In so far as this company differs from all previous concerns in its constitution, in its policy, in the site selected for its works and in the ore-beds to be exploited, it avoids the specific causes of failure attributed to earlier enterprises. No member or friend of this new company will deny that its

* T. H. Holland and W. A. K. Christie : "The Origin of the Salt Deposits of Rajputana," *Records of the Geological Survey, India*, Vol. XXXVIII., pp. 154-186, 1909.

inauguration will involve a series of factors operating under previously untried conditions of natural resources, labour, management and market. Some of these uncertain factors can be estimated with fair precision, and for the others there appears to me to be provided a margin of safety sufficient to ensure success. The works will probably be ready to commence operations towards the close of the present year, and the progress which has been made towards construction and towards development of the ore, flux and fuel adds credit to the great reputation of Messrs. Tata, Sons and Company, who initiated the enterprise, and are now the managing agents and principal shareholders in the new company.

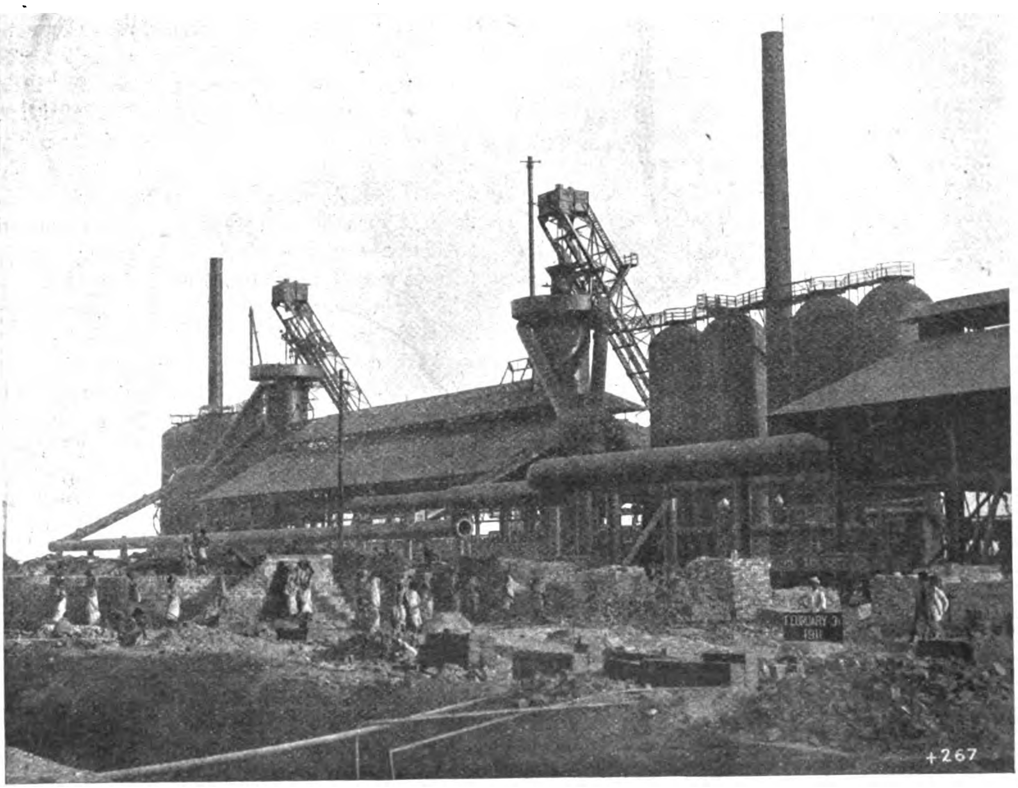

FIG. 7.—TATA IRON AND STEEL WORKS.
Progress in construction of blast-furnaces on February 3rd, 1911.

The new company propose to exploit the hematite ore-bodies of the Mourbhanj State in Orissa, where they have in sight all that they are likely to require for many years to come of an ore containing on an average over 62 per cent. of iron, with a content in phosphorus that is low, but nevertheless sufficiently serious to require preparation for the basic process in steel manufacture. The same company hold mining rights for a larger and a richer body of hematite in the Drug district of the Central Provinces, but it is doubtful if this reserve will ever be required to serve the new works. For coal and coke the company will rely on the resources of newly-acquired collieries on the Jherria field, and for flux on deposits of dolomite and limestone in Chota Nagpur, as well as on the well-known limestone of the Katni area. They have secured a site near the Kalimati railway station, 153 miles west of Calcutta, on the main line of the Bengal-Nagpur Railway, where they have abundant room for accommodating the new colony of workers on a healthy site, with an abundant water-supply for the workers and the rest of the community. The new works will be within 45 miles of the principal ore-supplies, and 130 miles from the collieries. With these advantages in the cost of assembling raw

materials of high quality, there should be no difficulty in competing with imported steel and iron of certain kinds and sections at Calcutta, which is the principal market for finished products.

The general idea that India is rich in iron ore is due to the fact that the smelting of iron was a widespread industry throughout the country for many generations before the British occupation. In addition to the smelting of wrought iron by a direct process in small "bloomeries," the natives of India formerly made steel of excellent quality, which had acquired a wide reputation even when Alexander the Great invaded India. The native smelting industry persisted in most parts of the country until the importation and distribution of cheaper European iron and steel became possible by the opening of the Suez Canal and the spread of railways throughout the country. After the European products obtained access to the country, the native smelter found it impossible to live, except in places far from the lines of railway, and thus the old-fashioned furnaces may be found still at work in remote parts of Madras, Chota Nagpur, Orissa, and the Central Provinces.

The simple requirements of the small native "bloomeries" are satisfied with deposits which, to the modern ironmaster, would not be worth consideration; consequently, the widespread industry of smelting does not necessarily mean the presence of ores in large quantities. A common source of ore is the formation which includes quartz-hematite and quartz-magnetite schists of the kind found in the Huronian and other pre-Cambrian systems of many parts of the world. These rocks are widely distributed throughout the crystalline areas of India; and although small "bloomeries" can be served by crushing and concentrating the friable fragments of these rocks, many of the occurrences cannot be regarded at present as sources of ore of commercial importance.

In many places the quartz-iron-ore schists form thick and persistent bands of great dimensions, including a total quantity of ore that might be considered serious if economical methods of concentration could be adopted; but it should be remembered that many of the old reports referring to these deposits as "inexhaustible" and "enormous" were based on the fact that the deposits were then out of all proportion in excess of any probable local consumption. It is quite possible that the formations of quartz-iron-ore schists in the Salem district, Madras Presidency, in the Mysore State, in the Nizam's Dominions, and some other parts of the crystalline areas in Peninsular India, are of a kind that might be considered large, but detailed estimates have never yet been made.

In considering the possibility of recent enterprise being successful, and of developing on a larger scale and at other localities, it must be remembered that, although the total requirements of India in iron and steel are large, the ports through which foreign steel arrives have the advantage of being within striking distance of the principal consuming areas, and the ports are not necessarily near the most suitable sites for smelting works. A large fraction also of the total value of imported iron and steel is made up of a greatly varied assemblage of shapes, sizes, and kinds of ordinary finished iron and steel, as well as of machinery, mill-work and plant, which have a value far in excess of the cost of the simple iron and steel employed in their manufacture. During the past five years the imports into India of iron and steel materials have risen in value from about 13 to over 22 millions sterling, but of this total only some 7 or 8 millions sterling can be regarded as iron and steel in a form that will be manufactured by new works in the country, and of this fraction a portion must be ruled out of consideration, on account of the fact that it pays only to manufacture a limited number of sections which are greatly in demand within reasonable distance of the works.

It is quite possible that in times of high prices iron ore of richness and quality equal to that being opened up by the Tata Company might be exported to Europe and America. Present rates of freight from Indian ports, added to railway transport from the interior, amount to a serious fraction of the comparatively low price of a ton of iron ore. But deposits like those of Mourbhanj, carrying well over 60 per cent. of iron, and forming solid masses which stand up as hills above the general level of the plain, permitting of the simplest and most inexpensive form of quarrying, might very well find an outlet to the European markets when rich ores are in demand. It is obvious that the exploitation of deposits of this nature involves no capital outlay, and consequently a very narrow margin of profit will be worth considering; while there will be no difficulty in turning out large quantities of ore on slight notice to meet any sudden demand, the exploitation being easily curtailed, or even completely stopped during dull times, without incurring any tax more serious than the dead-rent due to the State. Even this charge would

not affect a company which requires, for its own use, sufficient ore to cover the dead-rent; such a company could easily, when required, increase its output of ore at a moment's notice to meet any sudden demand in Europe, and could relinquish its additional source of revenue without keeping idle any large quantity of expensive plant. Practically the whole of the additional output could be met by unskilled labour in the case of the Tata Company, for the railway siding will be pushed into the foot of the hill of solid ore, and this company could even mitigate the disadvantages of varying demands for unskilled labour by accumulating heavy stocks of ore of determined and uniform quality ready for dispatch on a guaranteed assay.

Minerals Raised for Export.

Of the minerals raised only for export, I propose to refer briefly to gold, manganese, chromite, magnesite, mica, and saltpetre.

Gold.

Although gold usually generates more public interest than other minerals, it is of less importance in India than in many other countries. In addition to its direct value as a source of revenue, the discovery of gold is of value to most colonies as an incentive to immigration. India already possesses a population as great as it can conveniently feed, and as the successful mining of gold merely adds to the list of luxuries obtainable within the limited area in which it is worked, gold is of less importance to the country as a whole than those minerals which might, or already do, contribute to the general industrial development.

In small quantities gold has been found in various parts of the country, but the only successful mining on a considerable scale that has occurred, has been until very recently limited to a small part of the Mysore State, where from 1887 to 1905 there was a gradual increase in production to a record annual value of £2,428,162. In the next following two years there was a slight decline, with a subsequent revival in 1908 and 1909, the output of the last-named year being valued at a little over two millions sterling. In 1903 gold production commenced at Hutti in the Nizam's Dominions, and the production in that area has gradually risen to an annual value of between £50,000 and £60,000. Smaller quantities have been obtained by mining during the past few years in the Dharwar district of the Bombay Presidency, where the reefs occur in rocks belonging to the same system as those which have proved to be auriferous in other parts of South India.

In addition to the small amounts obtained by native washers in various parts of the country, dredging operations for alluvial gold have been carried on during the past nine years in the upper reaches of the Irrawaddi River, the production for 1909 being valued at £32,730. It is possible that the companies operating in this area, and others who have been granted large dredging concessions over the river gravels of Upper Burma, may prove to be commercially successful when they recover from the effects of their early accidents and errors.

Manganese.

I have already referred briefly to the political bearing of the mining of manganese ore. It will be sufficient now merely to give a statistical sketch of the extraordinary development of this industry.

TABLE VI.

Production of Manganese Ore.

Year.	Total Production.
	Tons.
1900	139,265
1901	157,736
1902	144,325
1903	177,821
1904	150,190
1905	247,427
1906	571,495
1907	902,291
1908	674,315
1909	642,675

Although various occurrences were recorded for many years in the publications of the Geological Survey, no one apparently thought of working the mineral until 1891, when the deposits of the Vizianagram State, on the east coast, became opened up through the enterprise of Mr. H. G. Turner. For seven years this was the only district worked, the output rising year by year until it reached nearly 85,000 tons in 1899. When the still richer deposits of the Central Provinces became attacked, the total production in the next following three years rose to about 150,000 tons. In 1903 work

commenced also in the Jhabua State of Central India, and in 1905 the Bombay Presidency commenced to contribute to the total by the development of ore-bodies in the Panch Mahals; while operations commenced during the same year in the Mysore and Sandur States in Southern India.

The greatest production in any one year was reached in 1907, with a total of 902,291 tons. As the extraordinary rise in production between 1905 and 1907 was accompanied by, and mainly due to, an extraordinary rise in the price of manganese throughout the world, the total for values rose far more rapidly even than the total for quantities, and owners of manganese quarries amassed enormous profits; for the deposits worked were accessible to the simplest form of quarrying in solid ore-masses, and realisation of sales was limited only by transport facilities to the rail and to the coast. With the fall in prices in 1908, and general curtailment of activity in steel-smelting, many of the Indian producers were compelled to close operations, and all were forced to restrict their output.

For many years Russia, Spain, and Brazil were the principal producers of manganese, Russia always being by a long way the leader. India, between 1896 and 1899, began to compete with Spain and Brazil for the second place; and Spain having then dropped out of the competition, the race proceeded between India and Brazil until 1905, when India rapidly shot ahead. Its total production in 1905 was about one-quarter of a million, in 1906 over half a million, and in 1907 not much short of a million tons; thus, in the last-mentioned year it closely approached the record output of Russia. In the following year, when all countries were compelled to curtail their output of manganese, and the Russian mines in the Caucasus were

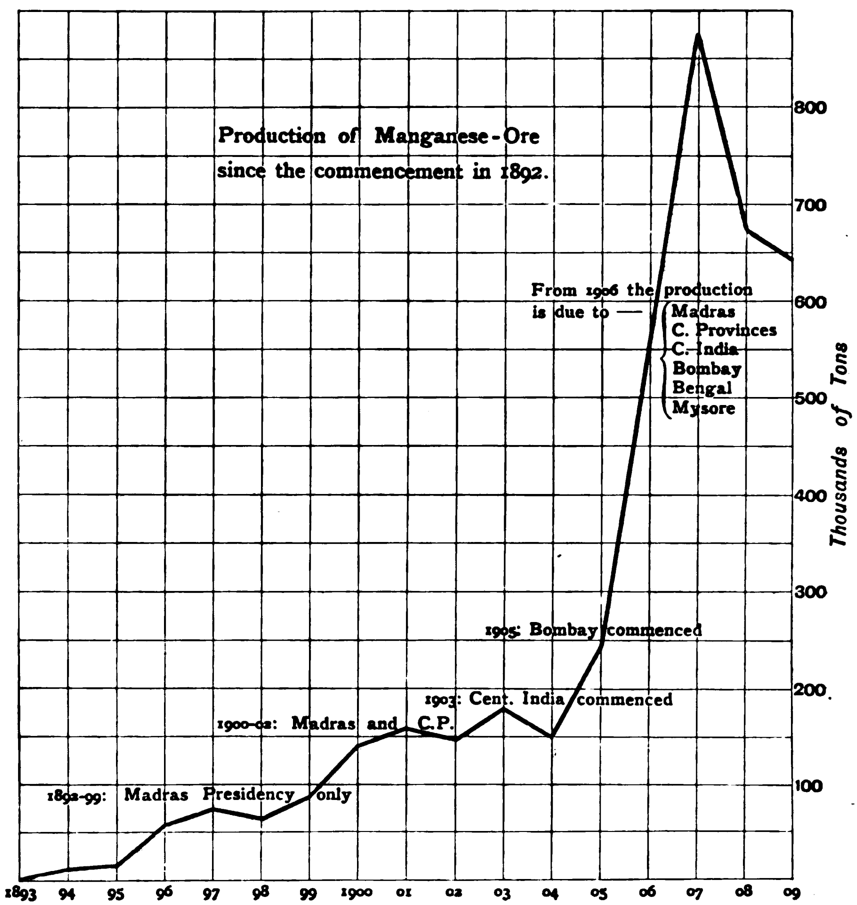

FIG. 8.

closed by political disturbances, India became for a year the leader.

Every question relating to the Indian manganese-ore deposits and their exploitation is discussed in detail by Dr. L. L. Fermor in an elaborate memoir recently issued by the Geological Survey.*

Chromite.

Although still worked on a comparatively small scale, the production of chromite for simple export is, like that of manganese, an industry which returns to the country at present a small compensation for the total loss of the mineral. Since the commencement of mining operations in Baluchistan during 1903, the output of chromite has amounted in that area to 26,697 tons; for this the Government has received in royalty and rents under £2,000, and would have received very much less, but for a local misapprehension of the rates for royalty laid down by the standing orders of the Government of India. The mining industry, which is of the simplest character, has maintained a small amount of labour in Baluchistan, but the total revenue received by the country is still but a small fraction of the market value of the mineral, which might be estimated at somewhere near £100,000. There is no doubt that the owners of the mines pay a tax that cannot be considered to be excessively lenient so long as the export of this mineral is permitted. The only question to be considered for Baluchistan, as well as for other parts of India where the mineral occurs, is the purely political one as to the desirability of depleting, without adequate compensation, our stores of a mineral which is likely to be of national importance for the manufacture of chrome-steel required for armour-plating.

The only other parts of the country in which chromite has been worked recently are the district of Singbhum in Bengal, and the Mysore State, the total production in these areas being so far under 20,000 tons.

Magnesite.

The olivine-rocks which have been worked in parts of South Peninsular India for chromite are generally also traversed by veins of magnesium carbonate or magnesite, formed by the alteration of the ferro-magnesian silicate, olivine. The most conspicuous occurrence, and the only one which has been worked to any extent, is that near the town of Salem, where the network of white magnesite-veins, covering low hills between the town of Salem and the Shevaroy Mountains, has given rise to the inappropriate name of the "Chalk Hills." For the last eight years the average production of the mineral in this area has been only 2,254 tons per annum, with yearly fluctuations so great as to indicate that the industry has not yet reached a state of steady production. The mineral produced is of unusual purity, and should consequently obtain a special value, but the only market for the calcined product is out of India.

The general criticism offered regarding the mining of manganese and chromite applies also to magnesite, of which the visible supplies are possibly below the probable future requirements for steel manufacture in India.

Mica.

Ever since mica has been a serious item of international trade, India has been by far the largest producer, the next two being Canada and the United States, while the output for other parts of the world forms but a small fraction of the total. Since 1894 the share of India in the total value of mica produced has varied from about 55 to 78 per cent., taking each year separately, or to a variation between 60 and 68 per cent. on consideration of quinquennial periods, as shown in the above table.

TABLE VII.

Average Annual Value of Mica Raised in the Three Principal Producing Countries.

Period.	Canada.	India.	United States.	Total.	India's per cent. of total.
	£	£	£	£	
1894-1898	14,598	*63,203*	15,030	*92,831*	*68·08*
1899-1903	32,110	*85,370*	24,477	*141,957*	*60·14*
1904-1908	57,070	*173,511*	50,260	*280,841*	*61·78*

* *Memoirs of the Geological Survey, India*, Vol. XXXVII., 1909.

Practically the whole of the mica produced in India is of the variety muscovite, which, on account of its hardness, elasticity, and freedom from foreign inclusions gives Indian mica a slight advantage in competition with the product from other countries.

The area which has been worked for the longest period, and is still the principal producer, covers the northern and western part of the Hazaribagh district, the eastern part of Gaya, and the south-western corner of Monghyr in Behar. Mica-mining in the next most productive area, namely, that of the Nellore district in Madras, dates from 1890, when a valuable mine was opened up through the enterprise of Mr. E. H. Sargent. Both areas owe their richness in mica to the same circumstance, namely, abundant intrusions of pegmatite veins among the schists, which, although belonging to the earliest of our great geological eras, have remained undisturbed by earth movements ever since. The slightest disturbance of the rocks would naturally result in the destruction of large proportions of a mineral so comparatively soft and delicate, for mica depends for its value largely on the flawless, uncrumpled condition of its cleavage sheets.

In Behar the mica-bearing country forms high ground which has been dissected out into scenic relief by the erosive action of the streams, and consequently in this area the mica deposits were first noticed and worked. In Nellore the mica-bearing country forms a flat and low-lying plain in which the rocks are largely masked by a mantle of decomposition products and cultivated soil, which effectually conceals the pegmatite veins. It is probable that there are still many valuable deposits of mica undetected in the Nellore district, in spite of the active prospecting which has followed the accidental discovery of a few valuable occurrences. In both areas the operations have been limited to depths that would be considered shallow in systematic mining. Although the primitive system followed, more conspicuously, perhaps, in Behar, has reached its productive limit in the case of many mines, a general reform in the methods of mining will be necessary for these two valuable areas to maintain their supremacy as mica producers.

Mica-mining in India must always remain in an uncertain condition until it becomes controlled by larger limited liability companies, who, with a larger capital and with smaller individual risks, will be able to adopt systematic mining operations to replace the present uncertain hand-to-mouth practice. The work so far done may be regarded as mere prospecting, and should form a valuable basis for planning operations on a scale sufficiently large to exploit the numerous deposits that still lie untouched.

Saltpetre.

Among the minerals exported, saltpetre is the only one that can be regarded as no permanent loss to the country, for it is produced by the action of so-called nitrifying bacteria under climatic conditions, especially in Behar, ideally suited for the transformation of decomposing, nitrogenous, organic matter into nitric acid, the necessary potash being so greatly in abundance that its loss will never be felt. There was a time when, on account of its position as the main source of saltpetre, India possessed special political importance, the occurrence of war or of a war-scare being sufficient to raise the price of the substance which was formerly essential in the manufacture of explosives. The discovery of other deposits of nitrates and the adoption of other compounds for the preparation of explosives, have reduced the value of saltpetre, whilst as an artificial manure it is being displaced by the potash deposits of Germany, by soda-nitre from South America, and by ammonium-sulphate recovered as a by-product in gas and coke making. The annual export from India has remained steadily for some years between 17,000 and 20,000 tons.

Possible Developments.

It would obviously be dangerous to attempt any detailed discussion of the mineral occurrences that appear to offer reasonable hope of exploitation. It is possible, however, in general terms to indicate certain occurrences that require more serious attention. Among these might be mentioned the alum-shales of the Punjab and North-West Frontier; the bauxite deposits, which are known to be rich in alumina in various parts of the Peninsula; barytes, which is in small demand for paint; various clays, including fire-clays, for the products of which there is a growing import bill now approaching £400,000 per annum; copper-sulphide ores, which in some cases may possibly be sufficiently rich in sulphur for the additional manufacture of sulphuric acid; gypsum, now raised to the extent of over 6,000 tons per annum in Rajputana for use merely as a white-wash; lead, zinc, and silver ores, known in small quantities in various parts of the country, and now being prospected on a considerable scale in Upper Burma; various rare earths, of which finds are reported from time to time,

including monazite occurring with the seashore sands of the Travancore coast; pitchblende, occasionally found with the mica-bearing pegmatites, and wolfram, occasionally found in considerable quantities with the tin deposits of Burma. With these might be considered also corundum and mineral waters.

Copper.

Among these substances, which in the usual words of the optimistic prospector offer "possibilities" of development, the most "promising" are perhaps the copper ores; they are widely distributed and have been considerably worked by a past generation, while the heavy and increasing demand for copper in India has recently attracted attention again to the question of developing the local ores. For some years past the copper imported into India has had an average annual value of about 1½ millions sterling, and the numerous projects in contemplation for the development of hydro-electric power promise an increased demand for the metal.

Copper ores are known to occur, and in the past have been considerably worked in the Nellore district of the Madras Presidency, in Rajputana, in Chota Nagpur, and at various places along the Lower Himalayas, from Kulu in the north-west to Sikkim and Bhutan in the east. In all these localities the ore is associated with rocks which resemble in geological relationships and lithological characters those known as the Lower Huronian of America. These rocks, consisting of various forms of schists and slates, are referred in India to a stratigraphical system distinguished by the name of Dharwar, the system of rocks in which the gold deposits are found in South India.

In continuation of the work initiated by the Geological Survey, operations are now in progress by the Cape Copper Company to test the probable value of the well-known copper-bearing belt which stretches for some eighty miles across the Singbhum district of Bengal. A locality which deserves further attention is Baragunda, near the Giridih coal-field. The thick ore-body opened up many years ago was not exploited, because the heavy fall in the price of copper discouraged the Company. Prospecting operations on a considerable scale are also in progress in the Darjeeling district and adjoining part of the Sikkim State, where unusual facilities for developing water-power will probably counterbalance difficulties of a local character in developing a mountainous country.

Bauxite.

Another mineral which deserves special mention is bauxite, of which large quantities have been identified in Bombay, the Central Provinces, Central India, and the Madras Presidency. Analyses of large samples in some of these cases have shown proportions of alumina well over 50 per cent., and they thus come into the class of bauxites which have been successfully worked elsewhere for the production of aluminium. Some of the concessions taken up for the purpose of working these deposits have fallen through because of foolish attempts to float companies for the purpose of manufacturing aluminium, instead of beginning in a more modest way with the extraction of pure alumina for export to existing smelting works abroad. There are one or two promising localities near which water-power might be cheaply turned into electricity; but it is evidently dangerous to incur a large capital outlay for the erection of smelting operations under unfamiliar conditions, while the manufacture of the pure oxide from the bauxite is a simple chemical process requiring small expenditure in power, and very little capital outlay in fixed plant. The low average price for raw bauxite at European ports would leave very little margin for profit after paying for the transport of the raw material from inland localities to the coast and thence to Europe; but as the purified oxide can be prepared economically on a small scale, and commands a price sufficiently high to make the cost of its transport comparatively unimportant, it is strange that none of the concession holders have so far commenced serious operations.

Corundum.

Among the smaller of the mineral industries, one that deserves more attention than it has received hitherto is the mining of corundum. For use as an abrasive substance corundum has been employed in India for many generations by the old *saikalgar* (armourer) and by the lapidary. The name is of Indian origin, and the original material used by Count de Bournon for his description of the mineral species came from South India. India is thus the home of corundum, and although the mineral has been raised for many generations in small quantities for use in the country, the known deposits have never been developed on any considerable scale for export. The demand for abrasive agents has increased during recent years, and has given rise to the production of artificial substitutes for emery and

corundum, such as carborundum, a compound of carbon and silicon made in the electric furnace, and alundum, or artificial corundum, now being manufactured from bauxite by the utilisation of cheap electric power at Niagara. Other natural and artificial substances of a lower grade of hardness are used to replace or to adulterate emery, such as crushed garnet and spinel.

In India corundum is widely distributed in various forms, and one of the occurrences, namely, that near Kangayam, in the Coimbatore district, resembles in geological features the deposits which have been worked recently on a considerable scale in the Renfrew district of Ontario. It is possible that in face of competition from natural and artificial abrasives in the countries of principal consumption, it would not pay at present to develop the Indian mineral for export to Europe and America. With, however, the growth of manufacturing industries in India, the mineral will probably receive greater attention.

Mineral Waters.

It is probably not out of place to draw attention to the importance of the numerous hot and mineral springs occurring in various parts of India. Their value, whether real or purely fanciful, is appreciated by the natives, and, in consequence of their unusual nature, they have become, in many cases, semi-sacred objects of reverence. It is possible that mineral waters depend much for their value on successful advertisement, but as there is a considerable importation into India of various bottled foreign waters, it may be worth the while of someone to make use of the local production.

Phosphates.

One of the most extraordinary features in connection with the trade of India is the large export of phosphatic manures in the form of bones. The exports during the past five years have grown to nearly 90,000 tons per annum, with a declared value of about £360,000. The loss of fish-manure and oil-cake can be made good by reproduction, but the phosphate of lime sent out in the form of bones has been derived from the soil, and, as India is singularly deficient in deposits of mineral phosphates, such a loss is serious for a country dependent almost solely on agriculture. When sulphuric acid is manufactured on a larger scale in India, and the chemical industries generally become thereby developed, it is probable that this loss of phosphate will be curtailed and the material turned to account in the country.

Alkalis.

Sodium carbonate and sodium sulphate, which were formerly among the chemical products recovered by primitive processes in India, are now neglected on account of the importation of cheap alkali. As, however, carbonate of soda, caustic soda, and bleaching powder are being imported in annually increasing quantities, it should be possible now or soon to manufacture soda with commercial success by a process such as the electrolytic process, in which the by-product chlorine can be turned at once into bleaching powder. Beside the demands of the extensive paper-mills, sodium salts are required for hide-curing and various other industries. With the cheap manufacture of alkali from salt it seems to be hopeless at present to expect commercial success for any attempt to collect the large quantities of carbonate and sulphate of soda, which occur diluted with the chloride in some of the lakes and subsoil waters of the dry regions. Reference has already been made to the decay of chemical and metallurgical industries in India, and to the fact that the demand for chemicals is growing in quantity and variety sufficient to maintain a family of products large enough to warrant commercial enterprise.

Political Considerations.

Some idea of the attitude of the Government to the mining industry may be obtained from the general rules prescribed for the grant of licences and leases. From the point of view of the miner and prospector they offer "concessions" on the whole more generous than those obtainable in our self-governing colonies. Whether the leases, which are based on these rules, sufficiently safeguard the interests of the country as a whole is a matter that will require review after some further years of development. It is possibly true that in the past our administrators have had a too nervous regard for the possible political complications which might follow any considerable influx of the class of people who seem to be constant accessories of every mining "boom," for such people are not likely to add to the general happiness of the community. But artificial interference with the natural causes of migration is always dangerous, and it is now recognised that the mining industries have more than once been local safeguards in time of famine; their development, at any rate, will modify that character of simplicity which, as I have said before, is a dangerous state of unstable equilibrium in the economic configuration of a large and over-populated country.

No administrator responsible for the progress of a country should risk the danger of burying the country's talents in the earth merely because their development adds to the responsibilities and worries of the district magistrate.

In addition, however, to the immediate interests of the mining community and the question of revenue, there is the greater question of India's future industrial development to consider when discussing our policy regarding mineral concessions. We should have before us always the two great considerations—(1) that minerals are absolutely vital to the industrial progress of any community, and (2) that, unlike the products of the field and forest, they can be used only once in the history of a country. The products of agriculture are capable of an unlimited reproduction, and the effects of bad farming form losses that are recoverable; but there are no artificial means for reviving a damaged mineral deposit; there are no fertilisers for exhausted mines. It should be remembered that exhaustion of a mineral deposit does not mean merely the removal of all minerals of potential value, but more often, unfortunately, it means the removal of the richest portion of the deposits that give the quickest returns to the capitalist, attended by the destruction for ever, from an economic point of view, of those deposits which are poorer but could be turned to account under certain conditions of industrial development. These are but economic platitudes, but, unfortunately, often forgotten in the cry for rapid development. The export of every ounce of raw material is a permanent and serious loss to the country, but obviously it is better to raise and export, even at a low rate, the certain surplus of our mineral products rather than allow it to remain of use to nobody.

It should be remembered that the conservation of the mineral products is in India not merely a provincial question; the future of the country as a whole is dependent on its minerals; the small amount of revenue obtained locally is unimportant in comparison with the great political question of economic independence, and the mineral policy, not only of Provincial Governments, but of the Native States, whose prosperity depends upon the stability of the Imperial Government, should be controlled with the greatest care. I would more readily grant the power of life and death to an administration than freedom in disposing of its minerals. The time is coming when the mineral question will be to India, in its geographically isolated position, one of the greatest of its political questions. We have there an enormous population rapidly learning the arts and luxuries of civilisation, and there is not one among those that are the luxuries of this, and the necessities of the next generation that are not dependent on its inorganic products.

There is no colony that has an external trade comparable to that of India, and no dominion of colonies that closely competes with it in this respect; but it should be remembered that its trade is still in the highly impressionable condition characteristic of a system in the early stages of its evolution. The traits that characterise the primitive system of barter are still prominent in India's external trade, which is largely a simple exchange of the natural products of a tropical climate for the manufactured goods of the more highly developed communities in the temperate zone. The opening up of other tropical regions will necessarily strike at the commercial prospects of India, while some of the products formerly obtained in abundance, through the rapid reproductive powers of a tropical climate, are now being manufactured more cheaply through the development of chemical science in Europe. India has soon to face these changing industrial conditions. The natural advantages of a rich tropical vegetation are now challenged, and in the new competition the Government must turn its minerals as well as its vegetable products to the best economical account. The country has lost nothing by the export of vegetable products that cannot again be reproduced; but to squander the mineral resources would be a crime to the country. Conservatism may be undesirable, but caution is essential.

Although beyond the immediate object of this paper, it is desirable to take this opportunity of removing, so far as false impressions can be removed, the well-advertised idea that the present so-called political unrest in India endangers the security of financial investments in mines as well as other industrial enterprises which involve expenditure on immovable plant. To me the form of unrest which has so far been manifested rather increases than otherwise the value of financial investments; for, among all results of our work in India, nothing has been so prominent in recent years as the general relaxation of discipline in the training of those who are about to take on the responsibilities of manhood. The recent schoolboy outrages will not be entirely regretted if they wake up our administrators, especially those at Westminster, to the importance of tempering a sympathetic rule

with healthy discipline, and the political stability of the country ought thus to be increased by this timely lesson.

DISCUSSION.

The CHAIRMAN said one or two little points had been suggested to him in connection with administrative matters. In his instructive and interesting paper the author mentioned that the Geological Survey Department, the commercial community, the mining industry, and the Government, were all practically at one as to the propriety of certain rules for mining licences and so on. He should like to give an illustration of how very great the change had been. At the time when Sir Thomas Holland went to India, he himself was in the Madras Board of Revenue, and that department was called upon to report on the mining rules, one of which was to the effect that after the expiry of the mining lease granted by Government, the surface was to be restored in precisely the same condition as it was when the licence was granted, no consideration being given to the fact that there might be some hundred thousands of tons of refuse on the top. That was now all changed. The author, by some astute method, had managed to accomplish what very few heads of departments had been able to do—he seemed to have obtained all the liberty he required for making his department as useful as possible. The intelligent office clerk, and possibly even some of the hierarchs, were sometimes prone to suggest financial or statistical statements for adding to annual reports, and that went on until the head of the department was very often overweighted with the writing of reports, and left very little time for doing anything else. He used to think in India that some officials regarded figures relating to facts as actually of more importance than the facts themselves. Lord Curzon made a most admirable attempt to get rid of that evil, and for a time was successful, but the disease was probably endemic, though it might be overcome in the course of time. The most extraordinary official statement he himself had ever had to sign was one that had to be sent to the Secretary of State some thirty years ago. The district he was in then covered about 8,000 square miles, and calculation was required as to the amount of carpentry work and masonry constructed during the year, and the notification was that it was to be put in pounds avoirdupois! He would not intervene further between Sir Thomas and the gentlemen with expert knowledge who were about to address the meeting.

Dr. WALTER SAISE said his interest in the subject of the paper was mainly with the coal question. Coal was not only the bulkiest and most valuable mineral product of India, but it was chiefly utilised on the spot for manufacturing and carrying purposes. But his interest was due chiefly to the fact that he spent thirty years in the coal industry in Bengal. When he went to India in 1878 the total output of that continent was 970,000 tons. Now it was nearly 12,000,000 tons, or thirteen times greater. He remembered at that time (in 1878) it was still a matter for discussion and argument as to whether Indian coal could be burnt on railways in the locomotives. He remembered seeing and reading a report made by a distinguished locomotive superintendent, in which it was stated that Bengal coal was not good enough for locomotive purposes, and that English coal must be used if speed was to be maintained on the railways. Nowadays Indian coal practically was the only fuel used on Indian railways, and speeds on Indian railways were quite good. The Bombay-Calcutta postal express covered the distance from Bombay to Calcutta in less time (about 8 hours less) than the P. and O. express from Calais to Brindisi, the distance being much the same. And that was done with Bengal coal. The use of Indian coal on Indian railways, to which the birth and growth of the Indian coal industry were mainly due,* was largely the result of the acquisition in 1870 by the East Indian Railway Company of its own collieries, against the wish of, and in opposition to, the then Government. For some years that colliery (Kurhurbaree Collieries) raised one-third of the total output of coal in India, and when the coal trade increased, by reason of demands for other railways, this colliery raised one-fifth of the output of India for some years. The East Indian Railway Company might be said to have educated Indian railways to the use of Indian coal. In 1890, when the output of coal for Bengal was 1,626,000 tons, the East Indian Railway Company made a further great step. That company deputed an officer to explore and map a coal-field of 180 square miles area—the Jherria Coal-field—published a map, and distributed copies to the landowners and merchants of Calcutta, and then built a railway into the coal-field. The Government of India had no part in this policy except a rather reluctant acquiescence. The result was seen in the output of to-day. That coal-field, tapped by the energy and foresight—and to the ultimate considerable profit—of the East Indian Railway Company, now landed 7,000,000 tons per year as compared with nothing in 1890, and the total outturn of Bengal had increased from 1,626,000 tons in 1890 to 11,560,000 tons in 1908, to the great advantage of the railway that encouraged the trade. He had related this little fact—not generally known—of the policy of the East Indian Railway Company, because it indicated that enterprise of this kind by either wealthy corporations or Government was necessary in that vast country where cheap carriage was the main problem, as it was in the case of coal. A new coal-field, Bokaro, was to be opened out by the joint enterprise of the East Indian and Bengal-Nagpur Railways, and would probably give a new fillip to the coal industry. A new coal-field with coal to be got merely for the trouble, so to speak, of shovelling it into wagons

* The coal used on Indian railways is still one-third of the total output, and may be looked on as the backbone of the trade, as it is continuous, and fluctuates slightly.

offered great inducements—where there was only unskilled labour and a large quantity of it available—for colliery enterprise. The only capital necessary was to provide shovels and picks on the part of the colliery owner and to put the coal into wagons, which the railways then take away. The expansion of the coal industry had been accompanied by an improvement in the methods of mining and colliery equipment, as Sir Thomas Holland's slides showed, and the management and labour had both become more efficient. The difference between 1878 and 1908 from his own experience he could say was very marked, and all for the better.

Dr. JOHN W. EVANS congratulated the Society on obtaining a paper from Sir Thomas Holland, who had set forth the enormous strides that had taken place in the mineral industries of India in the quarter of a century during which the Government had the good fortune to possess Sir Thomas Holland's services. The progress in India in this respect during the last quarter of a century had been greater than had occurred in the British Isles in perhaps three-quarters of a century. Sir Thomas early made his reputation amongst the mercantile community of India. He remembered lunching with him at a wayside railway station in Mysore, where a number of planters were discussing the visit of Sir Thomas to the State, and speculating as to what would be the results on the development of its mineral industries, none of them suspecting that the slim youth sitting by them was the man to whom they were referring. With regard to the future of the mineral development of India, there was nothing more difficult than to prophesy. The lines which it would follow in the next quarter of a century would probably be very different from those which it had pursued during the past twenty-five years, for there was no department of industry which might be expected to show throughout the world greater changes. In the extraction of metals from ores electrolytic methods would gradually be substituted for smelting, and the centres of industry would be to a large extent determined not so much by the distribution of coal as by the distribution of water-power. Where no water-power was available, and coal had to be resorted to, it required very little perspicacity to see that in many cases it would pay better to convert the coal into power and use the power in electrolytic processes in the extraction of metals than to employ it in what would in the future be considered the present crude methods. Whatever happened, however, the mineral industry of India in the future, as now, would owe an enormous debt, which could never properly be estimated, to the hard work and the intelligence of the late Chief of the Geological Survey in India.

Mr. ALLAN GREENWELL said that the paper vividly presented the great mineral wealth of India, and the complex social and physical conditions which governed its production. About five years ago he had the pleasure of going over the principal coal-producing fields of India and was much struck by the primitive methods that were used in coal production; but in the last few years with increased production the methods and apparatus had become very much more up-to-date. Improvement was bound to occur as the fields developed and the process of extraction became more closely allied to that in vogue in this country. Undoubtedly the trend of mineral production in India, especially coal, would very largely depend on the appreciation the Government had of the necessity of a close knowledge of the peculiar local conditions, and that knowledge could be only obtained by those who resided in India, and were acquainted with all its necessities.

Mr. PERCY BRAMLEY said he spoke as a man born and bred in India, and therefore to all intents and purposes a native of that country. With regard to the question of sugar, it had always struck him as very extraordinary that in a country like India, where the population were very large consumers of sugar, the market should be held by foreign countries. The consumption of sugar amongst the native population was enormous, but until some process could be introduced which would produce the sugar they required there would be a difficulty in competing with foreign markets. The natives of India did not want refined sugar; they wanted a coarse sugar known as *cheeni* or *shukar*, and also a form of condensed molasses called *gul*. If produce such as that could be produced in India there was a great opening. The sugar-cane was indigenous to the country, and there was no reason why India should be dependent on foreign supplies. With regard to oil, there was an enormous demand throughout the country amongst the common people for ordinary paraffin, which, during the last twenty-five years, had superseded to a large extent the ordinary country oil. In all village fairs, and in even the smallest villages, paraffin of sorts could be obtained. The market apparently was held now by Americans, but if the oil-fields of Burma and Assam could supply the want there were immense fortunes awaiting those who could develop the market. One point to be remarked with regard to coal was the increasing scarcity of the ordinary fuel of the country. Wood used to be very much more available than it was now, and the question of the fuel supply in northern India was becoming acute. There was an immense opening for coal for domestic purposes. It would be necessary, however, to cheapen the coal, and in that connection cheap transport was necessary. With regard to the railways the author had shown a map of the Raniganj coal-fields, showing the radiating railway lines. It was rather a pity that the rivers were not shown on the same map. Parallel to the railways was one of the finest natural waterways in the world, the Ganges and its tributaries, and the development of the waterways seemed to him to promise the opening-up of great possibilities in the question of transport. With reference to the Pench coal-fields in Central India, how far they were workable by waterways he did not know, but

it might be possible to get on to the head-waters of the Narbada. As to mineral waters, there were vast possibilities in the Himalayas, but whether the natives of India would ever be got to appreciate the value of mineral waters was very doubtful. On the subject of the education of Indian students, the difficulty in extending a knowledge of technical subjects amongst the people of India seemed to arise from the fact that until technical education was given to the working-classes who carry out the work the spread of knowledge would be retarded, because the class of student who came to Europe was not drawn from the working-classes. Any scheme of technical education devised for the people of India should be extended to the working-classes.

Sir James Wilson, K.C.S.I., in proposing a hearty vote of thanks to the author for a most interesting paper, said he had had the privilege of working with Sir Thomas Holland for a year or two when Secretary to the Government of India. The Geological Department was for a time one of the Departments with which he had to deal, and he had every opportunity of seeing the excellent work Sir Thomas Holland was doing in India. As Director of the Geological Survey, Sir Thomas added to our knowledge of the geology of India, not only from a practical point of view but from the scientific side, and he had watched his work as a scientific authority with great admiration. But Sir Thomas was not a mere scientific man; he could make a distinction between a geological theory and a practical business proposition, and his advice as to how the Government should deal with the people interested in the mineral development of India was always of a very practical nature, and was received, not only by the Government but by those interested, as sound and sensible. With regard to the attitude of the Government towards the mineral development of India, very often the Indian Government had been abused by impatient mining speculators and investors at home, who wanted to make money as quickly as possible. But the Government of India had other things to think of. Often there were questions of the ownership of the minerals below the surface, and the Government did not wish to encourage the mere company promoter, but desired to see that the people who were beginning to develop the minerals of India should do so in a reasonably practical way. Also it had to think of the interests of the people in the locality who generally owned the surface of the soil, and there were many difficulties which arose when a mining population came amongst a pastoral people and often ruined their character and their health. Naturally, therefore, there was occasionally some delay before a mining prospector obtained the lease he wanted. Sometimes there was a little red-tape and unnecessary delay, but on the whole the Government had shown itself ready to inquire into any grievances or complaints, and did its best to remove them in consultation with the people interested.

Mr. Abdullah Yusuf-Ali, I.C.S., in seconding the motion, said Sir Thomas Holland had dealt with a most difficult subject with the depth of an expert, the ease of an orator, and the humour of a man of the world.

The resolution was carried unanimously.

Sir Thomas Holland, in reply, said he was especially pleased to meet his old friend, Sir James Wilson, because it was under him as chief that the first review of the mineral production of India was prepared, and it was through his encouragement that the work was undertaken and carried out. He agreed with a great deal of what Mr. Percy Bramley had said, especially about the food supply in the United Provinces. It was all very well to issue Government orders to increase the amount of forests, but the amount of forests in India could not be increased without curtailing the cultivated land, and as there were more mouths to fill in India it was dangerous to reduce the cultivated land in order to increase the forests. He pointed out that the rapid development of the past few years was in no way the outcome of his work, but a merely fortuitous coincidence with his period of service. Much of the progress, however, was due to the foundation of systematic survey work accomplished by his predecessors and senior colleagues, all of whom, with himself, had worked in harmony with the mining community. He agreed with Mr. Percy Bramley in calling attention to the value of the great navigable waterways, but pointed out that the Narbada River could not be utilised as an outlet for the Pench valley coal. The river is separated from the Pench valley by the Satpura mountain range, while the river itself is not navigable. He recognised the value of Dr. Evans's suggestion that electrolytic smelting would in future change the form of metallurgical development; but it should be remembered that, on the peninsula of India, water-power can rarely be relied on as a continuous supply without expensive storage-reservoirs; the rivers vary so greatly in discharge from the monsoon to the dry season that many of the largest cannot be depended on for any serious supply of power throughout the year.

TWENTIETH ORDINARY MEETING.

Wednesday, May 10th, 1911; Mr. Edward Packard in the chair.

The following candidates were proposed for election as members of the Society:—

Côté, Thomas, International Waterways Commission (Canadian Section), Ottawa, Canada.

Fourie, Petrus Jacobus, Jansenville, Cape Colony, Union of South Africa.

Mott, Howard Schenck, 100, Broadway, New York City, U.S.A.

Piesse, Mrs. Adelaide E., Mountain Ash, Addlestone, Surrey.

The following candidates were balloted for and duly elected members of the Society :—

Boyd, Miss Emma S., 18, King's-road, Southsea, Hants.

Croll, George, Camden House, Chislehurst, Kent.

Holland, William W., Ph.D., Johns Hopkins University, Baltimore, Maryland, U.S.A.

Holman, Arthur, Ishapore, Bengal, India.

Howat, William Frederick, M.D., Hammond, Indiana, U.S.A.

Sanguinetti, Vivian, c/o Dr. H. H. Sanguinetti, 19, Camden House-road, Kensington, W.

Triggs, Bernard, c/o Messrs. Cox & Co., 16, Charing-Cross, S.W., and Royal Bombay Yacht Club, Bombay, India.

Wood, Casey A., D.C.L., M.D., Suite 1208, Chicago Savings Bank Building, State and Madison-streets, Chicago, Illinois, U.S.A.

The Chairman expressed the regret felt that the Earl of Denbigh had been unable to be present to preside, as his lordship had hoped.

The paper read was—

BEET-SUGAR FACTORIES.

By Hal Williams, M.I.Mech.E., M.I.E.E., etc.

I do not propose to-night to enter into a discussion, except very briefly, as to whether it will or will not pay to grow sugar-beet in this country, and establish sugar factories, because that, though the primary question, is the commercial one and outside the scope of this paper. It is a question, moreover, that cannot be decided without a survey of the international sugar market and the fiscal policies of the various sugar-producing countries. There is a popular idea that the sugar-beet requires an abnormal amount of sun, but this is incorrect, for what the root really does require is plenty of moisture up to, say, the middle of August, when the root is growing, and plenty of sun during September and the beginning of October. The climate of these islands may leave much to be desired from many points of view, but it does give the sugar-beet what it requires, and is admirably suited to its cultivation; in fact, experience has proved that better beet can be grown in England than practically anywhere else in Europe. The cultivation of sugar-beet on the Continent, where the climate is not so suitable, pays, and pays very well; and to any-one who has been through several sugar seasons there, and has seen the enormous extent of the industry, it is very remarkable indeed that an industry which is the life and soul, agriculturally speaking, of the north of France and Belgium, —to mention only one small sugar-producing area—can, with an even more suitable soil and climate in this country, less than one hundred miles further west, be without any commercial value at all. This state of affairs is the more remarkable and the more to be regretted, because while we in this country are suffering from very severe agricultural depression, and while large tracts of first-class soil are laid down in grass, which is the least intensive form of cultivation,

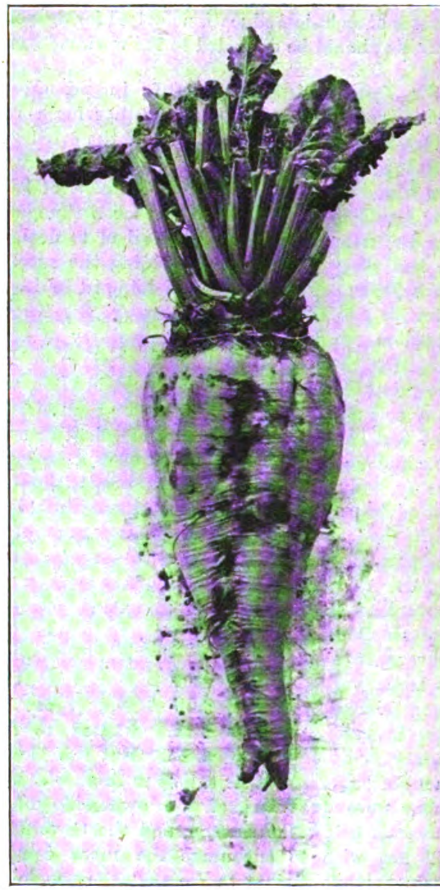

Fig. 1.

because it does not pay to grow anything else, there is hardly a piece of agricultural ground to be found in the Continental area I have just mentioned which does not bear a very profitable crop of sugar-beet at least every three years, and equally profitable cereal crops in the other two. In this connection also it is interesting to note that the cultivation of sugar-beet is increasing by leaps and bounds in the United States of America, where it is replacing the sugar-cane as a sugar-producer.

Beet gives the best results when grown with a two years' interval between successive crops, the best rotation being beet, wheat, oats. Fig. 1 is a photograph of a sugar-beet grown by Messrs. Sutton & Sons, Reading. You will observe that in appearance it is more like the common parsnip than any other root, and, like a parsnip, it requires a deep cultivation in order to get the best roots. It is for this reason, undoubtedly, that ground which has produced beet one year produces such excellent crops of cereals the other two. The roots are grown much more closely than, say, mangels, and the whole of the root should be covered with earth. For this reason they are more difficult to harvest than, say, mangel-wurzels, but any part of the root exposed to the sun and weather is valueless for sugar-making; in fact, even with roots which are completely buried, it is customary, before sending them to the sugar factory, to cut off a generous slice of the top of the roots with the leaves.

Fig. 2.

So much for the growing of the roots, which is, as I have said, a different department from that with which I have to deal to-night; to me the manufacture of the sugar with the huge possibilities it presents of introducing methods for saving time, labour, heat, power, and consequently cost, is by far the most interesting problem. I propose to describe the process in some detail, and if I can succeed in making myself clear in our imaginary journey through a beet-sugar factory, I am sure that you will be interested too.

Fig. 3.

I want to deal first of all with the way in which the roots are harvested and brought to the factory, and for this purpose I propose to show you some photographs which were taken

FIG. 4.

at a beet-sugar factory in the north of France last November, when the harvest, or "campaign" as it is called, was in full swing. Unfortunately, the weather was very wet, and as the sun had not its proverbial Continental brilliancy, the photographs are not as clear as

FIG. 5.

I should have wished. Fig. 2 is a very bad snapshot indeed of a beet field. I am disappointed that it should be so bad, because it was photographed in order to illustrate to you the small patches of beet which it pays the farmers to grow. The patch in question did not exceed some two acres, but it was harvested, and the beet carted to the factory all the same. Figs. 3 and 4 show the method of carting; the end of the sugar factory is shown on the left of the photograph. After the farmer has unloaded his roots, he takes the cart under the shoot (Fig. 5), from which the cossettes, or slices of beet after the sugar has been extracted, are delivered back to him. These are a by-product, used as cattle food, and are sent all over the country for this purpose. They are either mixed with about 4 per cent. of molasses, dried in ovens till they contain about 10 per cent. of water, and retained for winter food, or otherwise dealt

with. Fig. 6 is a view of the end of the factory, and shows the cossettes or slices being delivered into the railway trucks; while Fig. 7 shows trucks full of these spent slices, ready to be sent off to some more distant consignee. Fig. 8 gives a very good idea of the general appearance of the factory, and clearly shows the piles of beetroots which have been unloaded from either truck or cart waiting there to have their 15 or 16 per cent. of sugar extracted from them. Figs. 9, 10 and 11 are views of the same yard taken from the opposite direction. These photographs give a very good idea of the sea of beetroot waiting to be dealt with. To the right of Fig. 11 you will observe what looks like a ditch, with a man in the foreground cleaning it out. This is one of the "hydraulic canals," and there is one of these water channels under each pile of beet that you have seen. Water is let into each channel in turn, and the roots are conveyed by this water into the factory, being partly washed on the way. This is the beginning of the process. When the roots, after passing along the channel, arrive at the factory, they are caught in the wheel (Fig. 12), which lifts both the beet and the water into the beet-washer (Fig. 13). These washing machines are of various types, but in each the washing is done by the beets themselves, which are kept

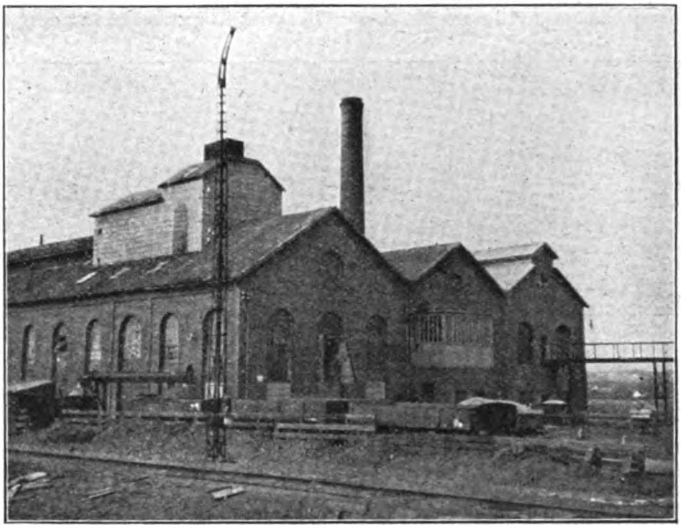

FIG. 6.

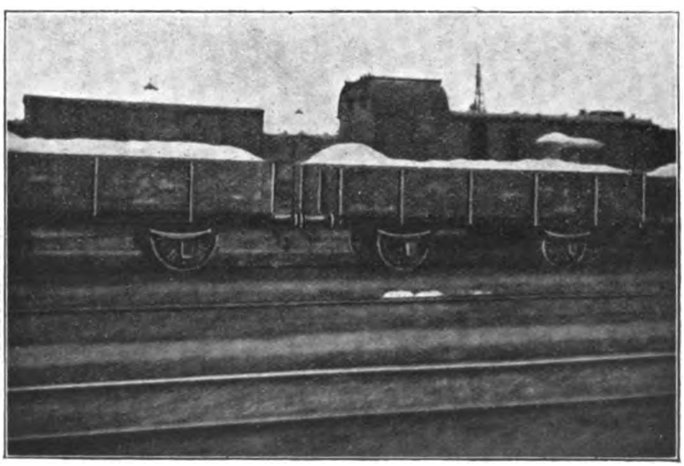

FIG. 7.

moving by the revolving arms shown, and which in consequence are cleaned by friction as they rub against each other. The cleaning is a very necessary and particular process, as small stones are very apt to get jammed in the roots, particularly if the ground in which they have grown has not been deeply ploughed, and the roots are bifurcated. These small stones play havoc with the cutting knives. From this washer the water returns to the channels to continue its work as a root conveyor, while the beet, after being weighed, passes up to the cutting machines, which, in order to get the full benefit of gravity, are frequently placed at the top of the building. These machines cut the beet into slices or cossettes of a corrugated or W section, the object of this shape of cut being to prevent the various slices lying so close together that the water which extracts the sugar cannot get to each surface.

FIG. 8.

as in Fig. 15. In either case the vessels are filled in turn with the freshly-cut slices. When the vessels are full, either fresh water, or water which has already passed through the adjoining diffuser, is let in, and the diffusers are worked in series in much the same manner as a battery of acidulating tanks until all the sugar in the slices, except about 0·2 per cent., which cannot be recovered, has been extracted. After diffusion, the water which has passed through the battery, and which contains the green or raw juice, is weighed and taken to heaters, and thence to the liming tanks, where it is treated with lime to remove the organic impurities. The cossettes, or exhausted slices, are removed by the elevator you see in Fig. 16, passed through the presses shown, which free them from the bulk of the water they contain, and are delivered into the carts or railway trucks, as we have seen in Fig. 5. An

FIG. 9.

After the beet has been cut, the slices are placed in the diffusers, which are arranged either in a circular battery, or in parallel rows. In the former case, considerable head-room is required, and the slices fall by gravity into the diffusers, as in Fig. 14. In the latter case the beet slices are conveyed to the diffusers by belt,

essential part of every sugar factory is the lime-kiln (Fig. 17), in which the lime-stone is calcined. This lime after burning is slacked to form milk of lime, which is mixed in carefully-measured proportions with the previously-heated green juice, which is then ready for the operation of the first carbonatation.

This process consists of treating the juice in special heated vessels with the CO_2 which was given off by the lime when burning in the lime-kiln, and which, after being caught and washed, is pumped into the juice. This CO_2 precipitates most of the lime as carbonate, and

FIG. 10.

the juice is partly purified. It then passes through filter presses as shown in Fig. 18, and is again subjected to the action of CO_2 in the second carbonatation, where it is further purified and again passed through filter presses. In some factories the juice is sent to the evaporators after this second carbonatation; in some it is first subjected to a third carbonatation and filtration. After the second or third

FIG. 11.

carbonatation, as the case may be, the juice is a light clear yellowish liquor at a density of 6 or 7 degrees Bé, and is ready for the evaporators. These liming tanks, heaters and carbonators are clearly shown in Fig. 19.

In the older factories the evaporators consist of the ordinary triple or quadruple effect pans with calandria, and are worked under vacuum, as shown in Fig. 19, but these are rapidly being replaced by the much more efficient Kestner Climbing Film Evaporator, working either with vacuum or pressure. One of these pressure evaporators is shown in Fig. 20; it evaporates 1,000 tons of water per twenty-four hours, which is the resultant from the 1,000 tons of beetroot dealt with in the factory. In other words, 1,000 tons of beetroot produce 1,250 tons of clear juice, from which 1,000 tons of water has to be evaporated. This is 80 per cent. evaporation, and in this particular case all the evaporation is being done under pressure with extremely efficient and satisfactory results. It would not be too much to say that Monsieur Paul Kestner has worked a revolution in the rapidity and economy with which evaporation takes place. In the ordinary type of evaporator the liquor to be evaporated has to remain in the vessel until the required density is reached. This is frequently a period of some hours, and the effect on the sugar juice

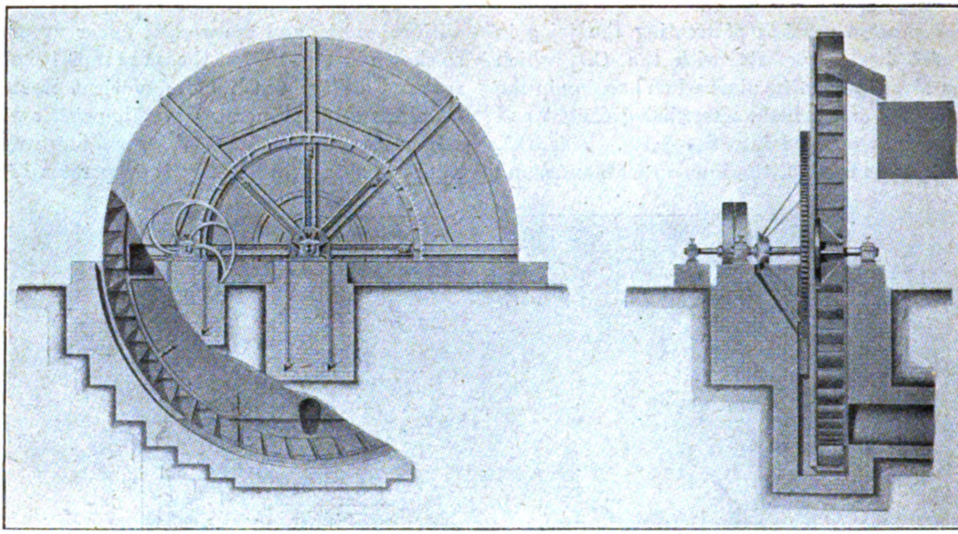

FIG. 12.

of so long an exposure to heat is deleterious. In the Kestner evaporator, on the other hand, it passes through in a continuous stream, remaining in the evaporator, and consequently in contact with the heated tubes, for a period of only about five minutes. After the juice has been evaporated to a density of 30° to 33° Bé in the Kestner, it is pumped into the boiling vacuum pans, which are of the ordinary type, where it is boiled—called technically boiling to grain—and evaporated until the malaxeurs, where it remains from four to ten days, and, when the sugar has sufficiently crystallised out, through centrifugal machines, which extract the second sugars. The molasses which remain are either sold to a distillery or are mixed with the dried cossettes and sold as cattle food. The treatment of both first and second sugars after evaporation will probably be considerably modified and simplified in future by a new process that is now being perfected by Monsieur Kestner. The present system is

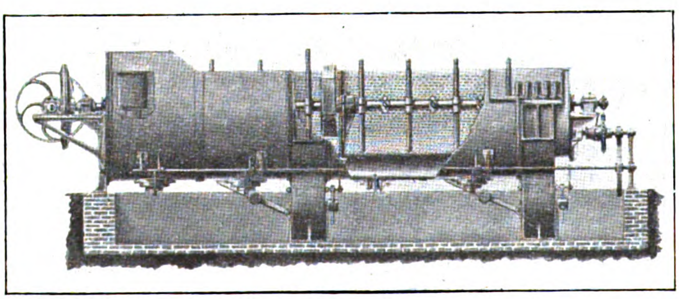

FIG. 13.

bulk of the sugar crystals have formed. It is then passed into cold malaxeurs, or stirrers, where it remains for from two to four days. These keep the mass of juice and crystals moving until the crystals have formed sufficiently, when it is passed into the centrifugal machines which separate the first crystals, known as the first product, from the remainder. The balance, consisting of mother liquor (*égout*) is sometimes and advantageously first treated with sulphurous acid, to render it less viscous, filtered, boiled to grain, passed through

an extremely lengthy and complicated matter, requiring very heavy and expensive plant.

The sugars of both the first and second product go to the refinery, usually a separate business, where they are dissolved in water to a solution of about 33° Bé, filtered through blackbone, and again boiled to grain. The wash liquors are evaporated, and the first, second, etc., products are turned into the many forms of white sugar which are so familiar to us.

This fleeting peep into the interior of a sugar factory, and the very brief summary of the

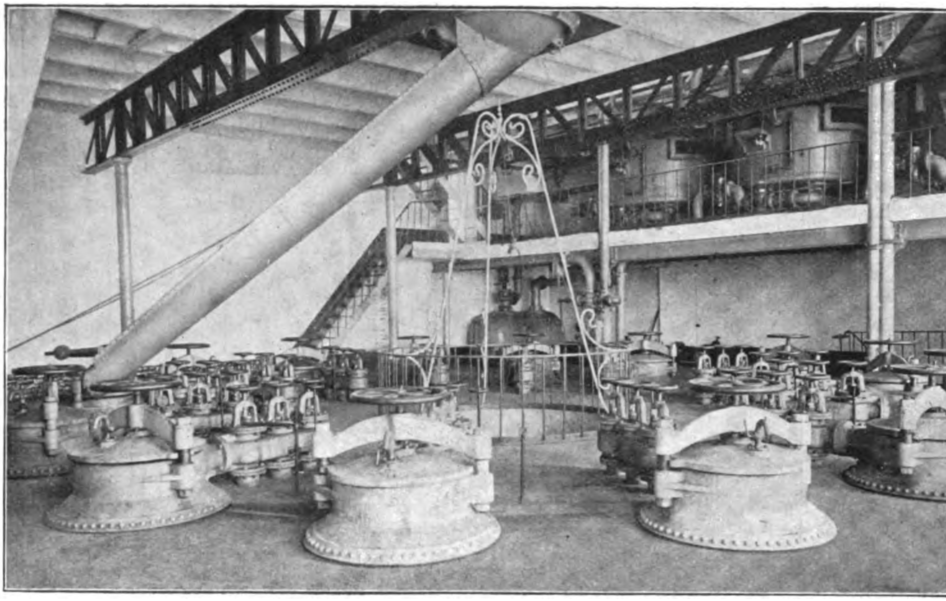

Fig. 14.

process of beet-sugar manufacture, will serve to show you that a sugar factory is not the simple place which so many people think it to be. It will also serve to give you some idea of the amount of money and thought which has to be expended upon its design, if the best and most economical results are to be obtained. The progress of the sugar from the time the beet first enters the factory till the time the bagged sugar leaves it, must be continuous and uninter-

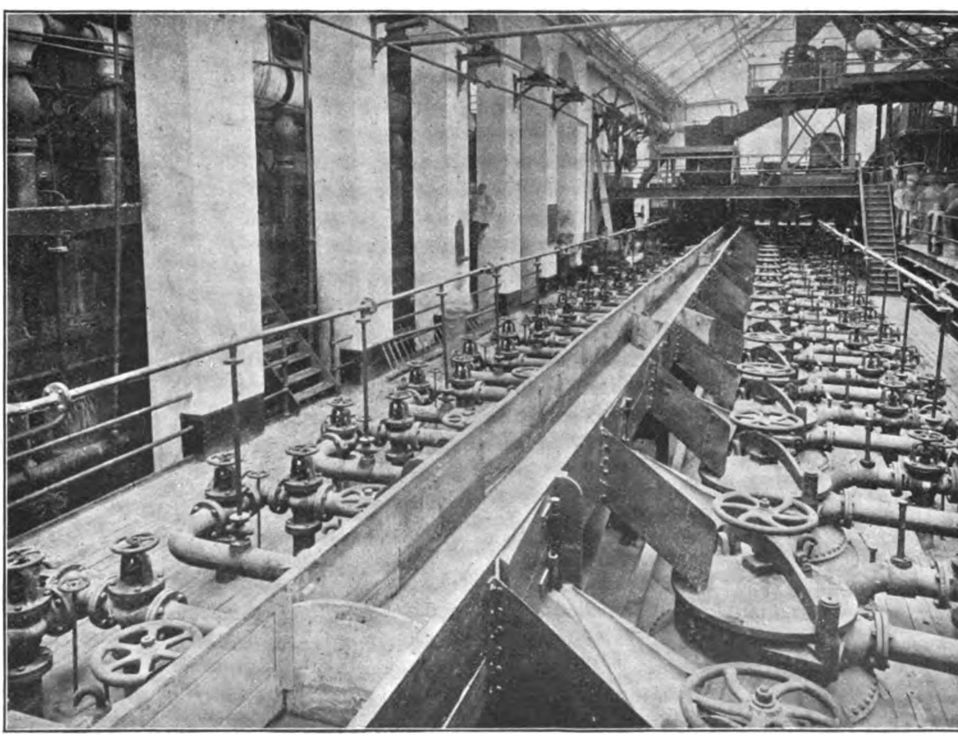

Fig. 15.

rupted; no ground must be covered twice, every available unit of heat must be utilised in suitable boilers and heaters, and every step forward must be as automatic as it is possible to make it. The molasses or waste material of the sugar factory is the raw material for several other industries, notably the distillation of alcohol, and the vinasse or waste of the distillery, or distillery wash as it is called in this country, is again the raw material for other industries. This vinasse contains the bulk of the nitrogen extracted from the soil, phosphoric acid, potash, soda and organic acids. It should really go back to the soil, but it is frequently used for making sulphate of ammonia and cyanide of potassium, so much used in gold-mining, and for killing blight in vineyards.

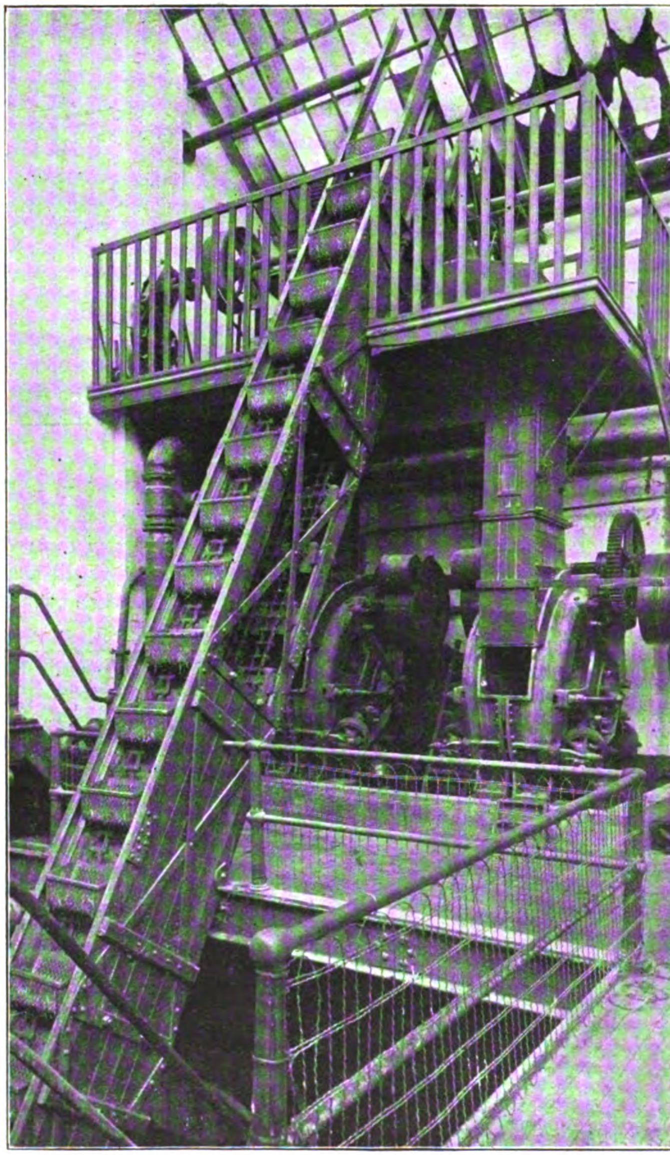

FIG. 16.

These different manufactories are all extremely prosperous, and if we consider the amount of capital on which they pay dividends and the amount they distribute in wages, we can reasonably ask ourselves—If for them why not for us? It is satisfactory to note, however, that at least some people in England are

alive to the importance of the question, and that the country is beginning to wake up. The admirable work done by the pioneers, particularly by Lord Denbigh, is likely to bear fruit in the near future.

The sugar factories abroad are of various sizes, the largest are owned by companies, many are owned by landowners who manufacture sugar from beet grown on their own property, while many are owned by farmers and run on the co-operative principle. A very good and usual size is a factory capable of dealing with 500 tons of beetroot per twenty-four hours, though there are many quite successful with a much smaller capacity, while many of the photographs which we have seen were taken in a factory capable of dealing with 1,000 tons per twenty-four hours. The process is, of course, continuous, and the "campaign" lasts about eighty days, after which time the factory is shut down for the rest of the year. A factory for dealing with 500 tons per twenty-four hours costs about £60,000, complete with buildings and plant. This factory would deal with 40,000 tons of roots per annum, which would represent the product under average conditions of, say, 2,500 to 3,000 acres, an amount of land which could easily be spared from grass growing.

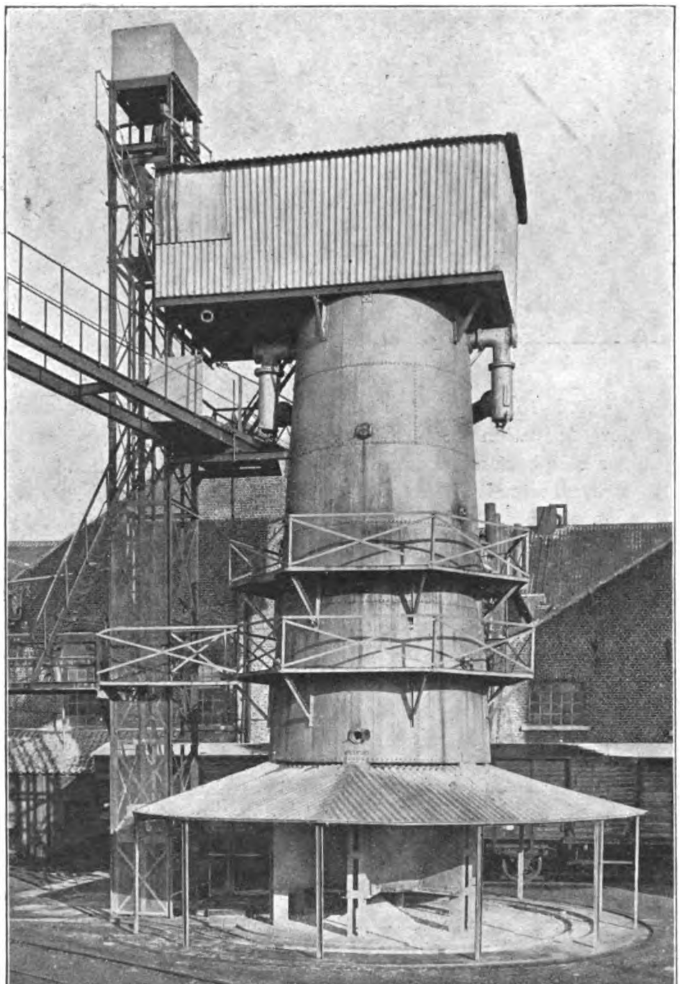

FIG. 17.

In England the beet might be expected to yield commercially about 17 per cent. of sugar, perhaps more. In France, where the soil is more exhausted, the average yield is 15 per cent., and in Germany 17 per cent., the larger yield in this latter case being possibly due to better seed, closer cultivation—notably manuring

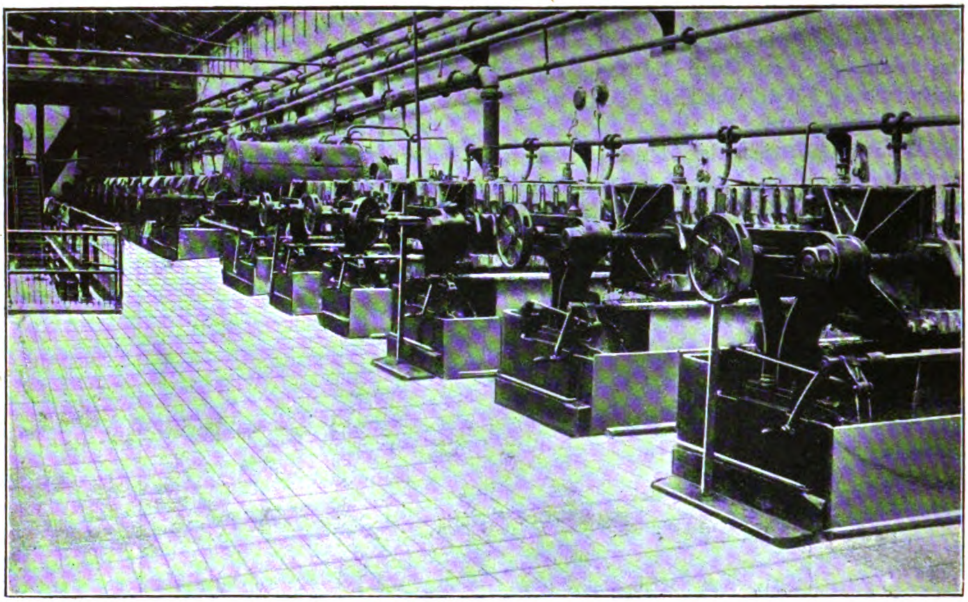

Fig. 18.

and deep ploughing—and to the fact that the larger area under cultivation enables the ground to get a longer rest between successive crops. There is, however, a great difference of opinion on these points. In France alone there were some 230 sugar factories, and only twenty refineries, this showing the importance of the industry and the relation between its two portions. In England we already have the refineries, why not the factories? During last autumn some 20,000 tons of sugar-beetroot were exported to Holland from England to be turned into sugar there.

I am merely a specialist in the building and equipment of factories, and am not a politician, an agriculturalist, or a fiscal expert; and it is, I suppose, because of my limitations in these latter directions that I am unable to understand

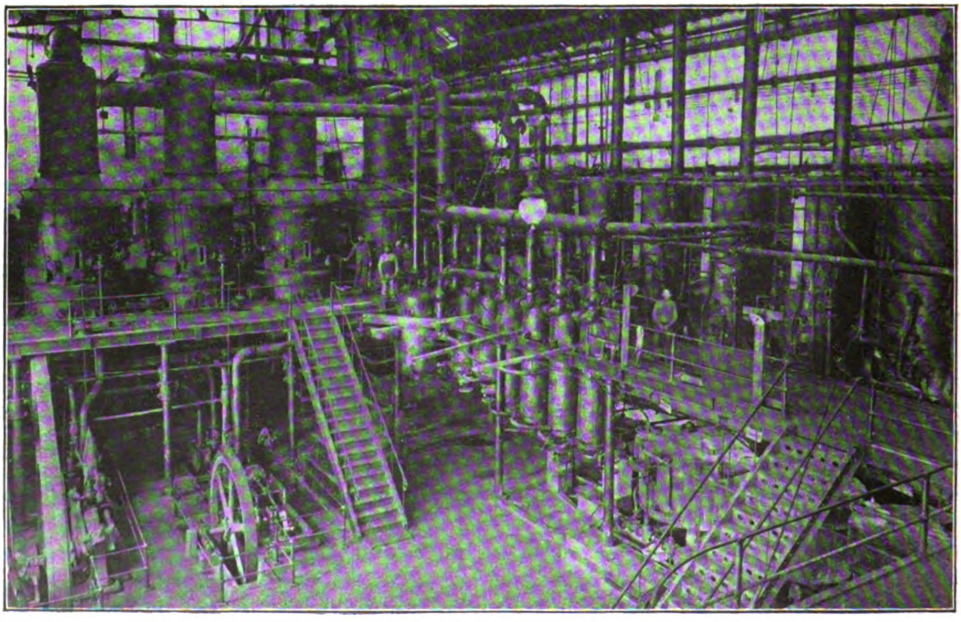

Fig. 19.

whether the inability of the inhabitants of the British Islands to produce and manufacture, at any rate, a large proportion of their own

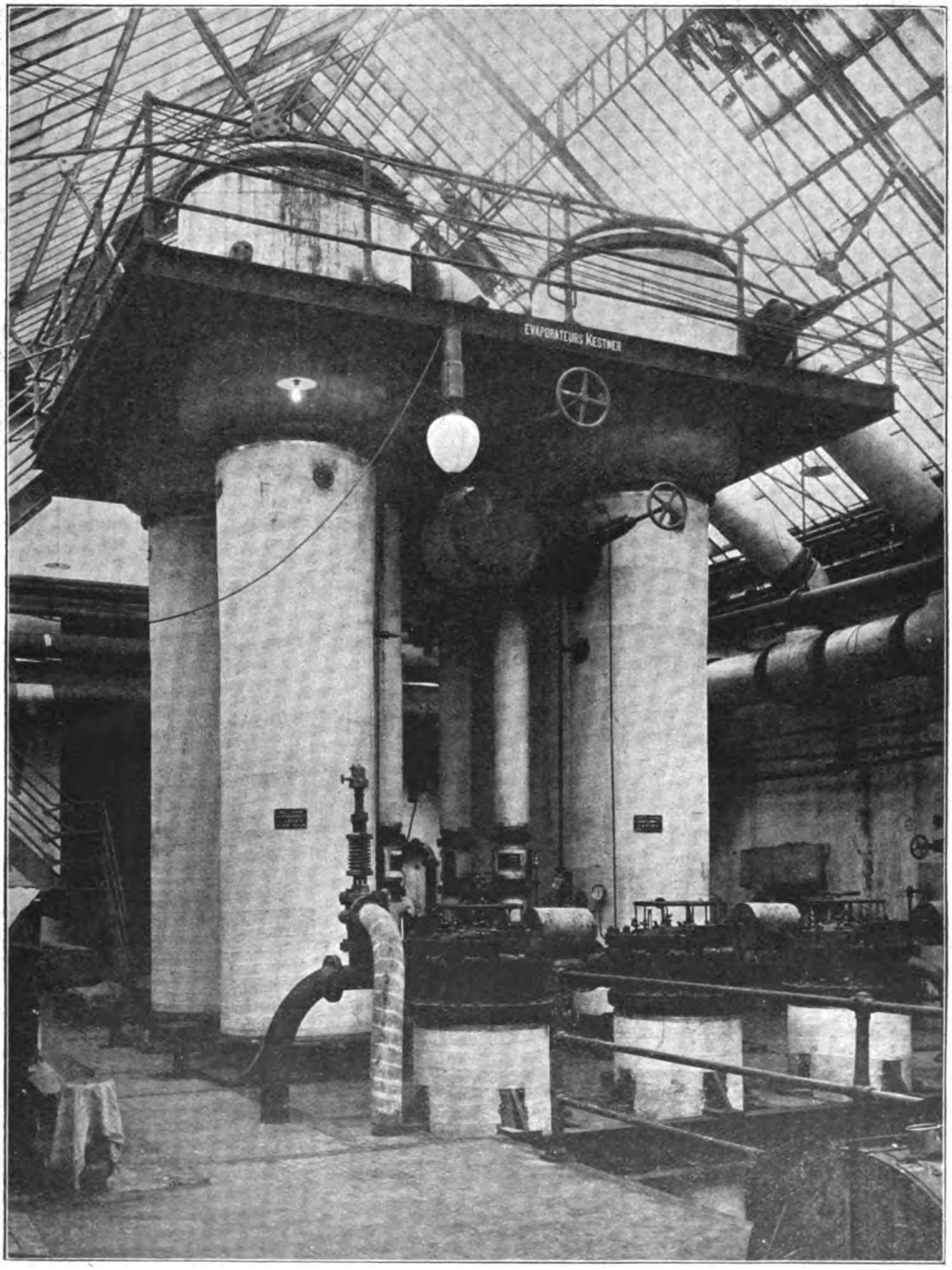

FIG. 20.

sugar, and to keep some of the many millions of pounds sterling which they annually send out of the country to pay for their sugar circulating amongst their own people, is really due to genuine and stable causes, or merely to apathy and ignorance. The proverb, "God helps those who help themselves," is as true to-day as when the expression first crystallised, and certainly our agricultural community does seem less fortunate in securing progress and prosperity than either their Continental neighbours

or their fellow-countrymen, who are working in other industries. Can apathy be the reason, I wonder?

It gives me pleasure to acknowledge my thanks to Messrs. Sutton & Sons, Reading; M. Gilain, Tirlemont; M. Alberic Dorzee Boussu, and M. Pellett, Lille, to whose kindness one or other of the photographs which you have seen are due.

DISCUSSION.

Mr. WALTER F. REID, F.I.C., said the subject did not deal with a branch of technology with which he was acquainted, but all who went often to the Continent must have noticed how great was the prosperity brought to certain agricultural regions by the cultivation of the sugar-beet. For such cultivation the land did not need to be very good, and the climate of Europe generally was not so good as that of England for the crop in question. Two years ago, in the autumn, when he was in Upper Silesia, the countryside seemed full of people; the explanation being that every available hand was anxiously looking after the beet, as there had been a frost the previous night. Every little while one came across a factory devoted to some agricultural industry, to make some material which English people imported, and which they might equally well grow themselves. This involved the important question of maintaining a large section of the people on the land. The extraction of the beetroot was now a matter of such accuracy, that the utmost could be got out of it; the experimental stage had long passed, and it only remained to adopt the latest devices. It would also mean the manufacture of a great deal of machinery for the purpose, and the accession of much traffic to the railways. In England there seemed to be much less corn grown than formerly, and much more land was given over to grass cultivation. The number of cattle, also, was diminishing, and that, too, in spite of the fact that we were importing milk from abroad. The demand for the beet industry was here. He asked how the masses of beet were protected from frost, which must act injuriously upon it. He concluded by reminding the meeting of an address to be delivered on the subject by the Earl of Denbigh at the Agricultural Hall on the afternoon of May 16th.

Dr. GUSTAF SCHACK-SOMMER said that England could certainly grow beet as well as any other country in the world. The question was whether it could be manufactured at a profit. The labour question was not a very large one, as the wages paid at the present day in Germany in the chemical industries were as high as in England. In Germany, the farmer who had once begun to grow beet never gave it up. Why should not that be the case in England also? The reason was that at present he had no inducement, and no tangible evidence that it would pay him. Why were not the rich people who were interested in sugar-refining coming forward and erecting factories for the beet industry? The reason was, that they were interested in buying the cheapest sugar. The farmer was the person who stood to benefit, and so any factories for that purpose should have farmers as shareholders. Mr. Rider Haggard found that the farmers in Denmark were interested in the sugar factories. In Germany and France the sugar factory was regarded by those nations as a Government agricultural school. The £60,000 mentioned by the lecturer for plant and buildings for treating 500 tons in twenty-four hours about coincided with what other authorities said; and that sum, if it was going to benefit the agricultural community so greatly, was not much to be found by the Government. Moreover, it would employ between 200 and 400 hands, a very important matter from the point of view of agriculture. He did not understand the remark of the lecturer that the Kestner appliance was without a vacuum installation; the Kestner appliance which he knew certainly had a pump. With regard to frosts, the beet grew beneath the ground, so that, until it was removed from the ground, it was not damaged by surface frost. And the "campaign" time did not exceed some sixty days.

Mr. G. L. COURTHOPE regretted the pictures shown by the author did not include some from Germany and Holland, as in those countries the industry was better organised than in France, especially the transport of the produce. So well organised was this latter, that seldom did the factories have more than twenty-four hours' supply on the spot at any one time. The question with regard to frosts seemed to have had reference to the beet when they were stacked. As the result of a calculation he made, the amount of beet-sugar imported into this country represented an expenditure of some ten million pounds sterling in wages for labour. And the extent to which beet was a cleaning crop was not sufficiently recognised; and one of the great advantages of beet was that it fitted in so well as a "rotation crop," and was much more profitable than swedes. He was informed on good authority that the sugar took nothing away from the soil at all, but, on the other hand, a lot of manurial product was put back in the land, so that the land gained from the crop. That fact explained why it was found on the Continent that where beet was produced, the yield of cereals in their due season had also increased, sometimes as much as 35 or 40 per cent. Why, in the face of those facts, had not the industry been established in England? First, because it must be done on a comparatively large scale to make it possible at all; there must be factories capable of dealing with as much as 500 tons in twenty-four hours, and 2,000 acres of land must be under cultivation each year for such factories, which was too large a quantity to get all at once. The £60,000 mentioned did not include the working

capital, and he did not think a start should be made on less than £100,000. Before investing his money, the capitalist wanted to be sure that the raw material was available to work on, and the farmer, before spending money on manures, wanted to be assured of a profitable market. Three attempts had been made in this country to introduce the beet-sugar industry, and in two of them there was failure because of avoidable mistakes. In one case, roots were contracted for, for delivery five months before the machines were in running order, and by the time the plant was ready the roots were not of much value. In another case—in Ireland—when a manager was wanted, a local publican was installed in that post. Another case was killed by the bounties which were levied in Germany in order to kill the industry in this country, which was showing great promise. But now that the bounty system was stopped in Europe, the fiscal future of the beet industry was simplified; it was possible for growers in this country to receive a moderate protection from the fiscal arrangements, limited to 2*s*. 6*d*. per cwt. in favour of the local producer as against the importer. We could compete in this country without that, though he would prefer we had the assistance of the 1*s*. 10*d*. per cwt. now in force. 20,000 tons of beets were exported to the Continent from the eastern counties this year, and it must be worth their while to do it, and for them to send the sugar back here as a manufactured article.

Mr. F. MacGregor Duncan called attention to the fact that eighteen months ago an attempt was seriously made to start the beet industry in this country, by establishing a syndicate—The Lincolnshire Beet-Sugar Company. Some gentlemen in Norfolk and Suffolk interested themselves in the matter, and when the time seemed ripe they took steps to construct a proper factory and grounds, and he (the speaker) was consulting engineer for the project. The syndicate obtained an excellent site near the Great Northern Railway, where there was water and other favouring circumstances. Visits were made to various German towns, and experts were asked to equip the factory with machinery which would yield a certain output. The public were appealed to for some £130,000. The contract for the building alone was £24,000, including much storage for dry beet. The contract for the machinery was £63,000, labour for erecting machinery £1,000, £2,000 for roads to factory, £3,000 for railway sidings, £2,400 for land, contingencies £6,000, working capital £18,000. The public responded by subscribing £50,000, which was returned to them. The firm who were to equip the factory worked night and day on the plans, as they felt the matter must succeed, and they were astounded at the result. The syndicate had entered into 264 contracts to grow beet with 264 farmers, whom it took two years to get to the point of entering into the matter. He agreed with what had been said as to the superior capacity of the Germans and Dutch to deal with the industry, as compared with the French. At the time the syndicate was trying to start the industry in England, people were tumbling over each other to invest in rubber shares. When the industry should be started, it was essential to get the co-operation of the farmers, and it should be for all time. In Germany, hosts of cottagers grew beet on their little plots of land, and at the due time carted it off to the beet factory. In England the first step should be, by means of lectures, to educate the people of the country on the matter, showing that there was an income practically waiting at their doors.

Mr. Arthur R. Ling congratulated the author on his paper, and said that in the autumn Mr. Matthews and he hoped to bring forward their work done on 150 samples of beet, which corroborated what the author had said as to the purity of the content of the English beet compared with that grown on the Continent.

Mr. Arthur Reavell, commenting on the question of the Kestner Evaporator, said Mr. Kestner was the first to find out the relation of heat and time together, and the effect of those factors on the sugar; he also found that in the process of evaporation one was able to keep the liquid in contact with the heating surface for only a minute or less, for a single effect; and for a quadruple effect, up to five or six minutes. The pressure-evaporators had a pressure of anything up to forty or sixty lbs. and instead of a vacuum, the vapour was taken away at a pressure of from one to ten lbs. The juice so treated was clearer and brighter, and produced better sugar than when treated under a vacuum. He was speaking of the concentration of the raw juice; the essence of the Kestner system was time.

The Chairman, in proposing a vote of thanks to Mr. Williams, said he was himself better acquainted with the manufacture of cane-sugar than with that of beet-sugar on the Continent. In 1885 he made his first experiments in growing sugar-beet in this country, and he proved in a few years that as good beet could be grown here as in Germany. Since then, seeds and methods had been improved, and so the yield per acre was increased. He believed in the British farmer, and his capacity to grow any produce against any farmer in the world. Still, it had not been proved that in this country we could convert the beets into sugar at a profit; yet it was most important, in the interests of both labour and agriculture, that the trial should be made. But at present the capitalist did not see his way to put down the money. The working farmer could not put down £60,000 for an experiment; it was often a difficulty for him even to make ends meet. He was not in favour of going to the Government for everything that was wanted; he believed in self-help. The matter was of national importance, and he did not see why it should not

be made to pay in this country. In regard to the efforts of the syndicate, he did not think the amount subscribed by the public was nearly as large as £50,000. By ventilating the question in that and other public ways, he hoped the attention of the public would be drawn to it, and that the assistance hoped for would be obtained.

Mr. WILLIAMS, replying on the discussion, said two questions—concerning frost and the Kestner evaporator—had been answered by other speakers. He did not show slides illustrating German factories, because his French was better than his German, and beet factories did not differ much in principle, though, like breweries, they differed in detail; it was chiefly a matter of personal idiosyncracy. He purposely did not depict the most up-to-date method of handling the beetroots before they entered the factory, as he wanted to bring out the point that if beet could be profitably handled with bullock-carts in the manner shown, it would be much more profitable under modern conditions. In some Continental factories some of the machinery was not modern, because the manufacturers could not afford to scrap their machinery when it became out of date and buy new. In England they would be starting *de novo*, with all that was best, most modern, and most economical. He contended that the figure he gave in the paper—£60,000—was right. But of course there was plant *and* plant, and there were buildings *and* buildings. He considered electric driving quite out of place in a sugar factory which was compact and where all exhaust steam was profitably employed. With regard to the response of the public to the attempt to float a company, it would have been wiser, before going to the amount of trouble which had been undertaken, to get the necessary capital underwritten. Possibly the public did not respond so much as the farmers, because they were not given the same inducement.

THE PEARL-FISHING INDUSTRY OF THE AMERICAS.

The richest pearl fisheries in the Americas at the present time are those of the Gulf of California, centering around La Paz, and along the outer coast of Lower California, in Mexico. These fisheries were discovered by Hernando Cortez when he marched across Mexico in 1526. The principal beds are near La Paz, in the Gulf, Espiritu Santo, Lorenzo Point, off the island of Cerrabro, Los Coyotes, and Mulege Bay, and, in fact, along the entire west coast of the Gulf from La Paz to above the island of Loreto and Tiburon on the east side. In addition to those found along the outside coast of Lower California, pearl oyster beds are also found at points along the southern coast of Mexico and Nicaragua, but, owing principally to the lack of protection for vessels, fishing has never been successfully carried on at these places. A few oyster beds have been found in the Gulf of Campeche, on the Atlantic side of Mexico, and a bed nearly ten miles long was located not long ago off Punta Santa Cristobal. These beds are now being worked under concession from the Mexican Government. Up to thirty years ago, *buzos de cabeza*, or head divers, only were employed on the La Paz beds, but on the revival of fisheries about this time, modern diving apparatus was introduced, and to-day they are being worked under concession by San Francisco firms, who employ from eight hundred to a thousand men. There are two classes of divers—those who go down head first and who use no weights to facilitate descent, and those who go down feet first. The pearl shells from these waters are not as large as those of Ceylon, but run from 6,000 to 7,000 to the ton. The true pearl oyster, the Meleagrina of the Indian and South Pacific oceans, varies in diameter from two to eight inches, according to age, six inches being the average. The greater part of the shell from the La Paz fisheries is shipped to San Francisco, while most of the pearls go to Mexico city and Paris. In 1908, the production of these fisheries was valued at £1,000,000, the pearls representing £600,000, and the mother-of-pearl shell the balance. The Lower California pearls are of a great variety of shapes and colour. Some very famous pearls of history have been taken from these waters. One of the most beautiful gems of the Spanish crown is an enormous Mexican pearl, found near Loreto by a native diver, and weighing 400 grains. Among the poorest natives of Mexico beautiful pearls are often to be found, usually mounted very crudely in rings, combs, earrings, chains, etc. The Gulf of Mexico was at one time famous for its production of the rare black pearl, and a number of these have recently been taken from the beds in the Gulf of Campeche. In Venezuela, according to a recent report by the International Bureau of the American Republics, the principal oyster beds are located around the island of Margarita, and at Cubagua, El Tirano, Gulf of Paria and Coro, Porlamar Maracapana, and Macanao, so that this part of Venezuela became known to the early Spaniards as the Pearl Coast. It is said that, in 1579, King Philip of Spain obtained from Margarita a magnificent pearl weighing 250 carats, and variously estimated as being worth from £6,000 to £20,000. The Venezuelan pearls are of very good colour, and these fisheries are specially famous for the number of beautiful baroques found. During the early days of the Spanish in the Caribbean, great numbers of fine pearls were found in the waters about the island of St. Thomas, and within late years Haiti and Santo Domingo have produced many delicate white pearls. It was in the Bay of Panama that the Indians first demonstrated to Balboa the manner in which they fished the pearl oyster. The principal fisheries of these coasts are among the Islas del Rey, or King's Island, now known as the Pearl Islands, lying in the Gulf of Panama about fifty miles from the city of Panama, and consisting of Rey Island, Pacheca, Pedro Gonzales, San Jose, and a number of smaller islands to the

north. Other important fisheries are found among the islands of Coiba, Coibita, Jicaron, Secas, and Contreras to the north-west, and off the south coast of Chiriqui and Veraguas. Rich beds have been found at times along the shores of the Golfo Dulce in Costa Rica, and around Punte Burica in Panama. Some beds are worked along both the Pacific and Atlantic coasts of Colombia, and on the Pacific side as far down as Ecuador and Peru, although not to any considerable extent, owing to unfavourable conditions prevailing, due to tide and unprotected coast-line. Of the Pearl Islands of Panama, Rey Island is the largest of the group. The only village of any size among these islands is San Miguel, as old as the fisheries themselves, the tower of its little masonry church being thickly inlaid with beautiful shells from the fishing grounds on all sides. At the present time there are about twenty diving machines and three hundred head divers at work on the Costa Rica, Panama, and Colombia pearl fisheries. The divers of these waters, as well as those of Mexico, suffer more from deafness than do the East Indians, the average depth of water in which they work being greater. The shell that comes to the market from the west coast of Central and South America is known as the Panama shell, and is usually of a bluish-black tint, The oysters average five to six inches in diameter, although some very fine pearls have been found in smaller ones running from four to five inches. In Colombia the concessions for the Atlantic fisheries, as well as those of the Pacific, are leased for a term of five years. The Costa Rica, Panama, and Colombia fisheries are famous for their black, green, and bluish-tinted pearls, although many beautiful delicate pinks have been found. In March, 1909, there was found, on the south coast of Chiriqui, a pearl weighing 42 carats, about the size and shape of a partridge egg, greenish black at the base, and becoming lighter towards the tapered end. The most beautiful pearls found on these coasts are rarely offered for sale in Panama, but are sent direct to Paris. From the United States and Canada come the fresh-water pearls, which are produced principally by the Unio, a species of mussel common to all the mountain streams throughout the country. In 1857, a pearl of exquisite lustre, weighing 93 grains, was found near Paterson, New York, which became known as the Queen Pearl, and which came into the possession of the Empress Eugenie of France. Pearls have been brought to the New York market from almost every State in the Union and Canada, principally from Ohio, Indiana, Illinois, Kentucky, Missouri, Arkansas, Michigan, Minnesota, Tennessee, and Mississippi. Garcilasso Inca de la Vega gives an interesting account of the manner in which the Indians of what is now Southern Georgia obtained their pearls, and their manner of using them. He states that the chief came to De Soto one day, bringing him a present of a string of pearls five feet in length, which were as large as filberts, and "had they not been bored by means of fire, which had discoloured them, would have been of immense value." He informed De Soto that these pearls had been gathered in the neighbourhood, and that in the sepulchres of his ancestors were amassed prodigious quantities of them, of which he was welcome to carry away as many as he pleased. In describing the manner in which the Indians strung their pearls, he says "the Indians were apt also further to injure the pearls obtained by boring them with a heated copper instrument." The conch shell found in the West Indies, along the Florida coast and among the Catalina and Santa Rosa islands of California, yields a pearl of beautiful pink, and often of symmetrical form, but, not being nacreous, cannot be considered a true pearl. With the opening of the Panama Canal, or even before, and the use of more modern diving machinery and systematic planting, such as is being successfully employed on the Mexican and Australian fisheries, the once famous pearl fisheries of the coasts of Costa Rica, Panama, and Colombia might again rank among the richest in the world.

THE PORT OF ANTWERP IN 1910.

The increasing commercial development of Belgium and the special activity of Antwerp lend considerable interest to Sir Cecil Hertslet's report on the shipping and navigation of that port for the year 1910. For the Port of London the prominent position that Antwerp is rapidly assuming, as one of the world's principal ports, possesses a peculiar significance. The shipping returns showed a very considerable increase of six per cent. over those of the previous year, thus again establishing a record for the port, and the new basins opened only four years ago proved on more than one occasion insufficient for the growing needs of the port, vessels being compelled to wait their turn before being able to take up their berth positions. In addition, labourers and employers are now in harmony, and the Consul-General is of opinion that there is no cloud to darken the horizon of commercial prosperity.

A point of some importance as affecting British prestige is that the Congo Mail line was in 1910 taken over by Belgium in fact as well as in name. Up to February 1st, 1911, this line had been entirely British as regards capital and working, though the vessels flew the Belgian flag under agreement, but since then the "Compagnie Belge Maritime du Congo" has been absorbed by a company, the representative capital of which is 60 per cent. Belgian, 20 per cent. British, and 20 per cent. German. Still British interests do predominate, and will doubtless continue to do so, though the rate of increase is not so great as before.

The desire in Belgium is very general to assist the national merchant marine, but the numerous attempts in that direction have never met with any great degree of success; the Belgian adapts himself to most conditions, but, generally speaking, he is not a good sailor and cannot compare with seamen

of other foreign nations such as the Scandinavian races.

The returns for 1910 show a larger number of vessels of a considerably greater tonnage than have ever before visited the port in one year. Moreover, there is every prospect of the figures for 1911 proving a record: freights are better, imports and exports are increasing, while, as a surest sign, there is a general aspect of contentedness, together with brisk movement in commercial quarters, giving evidence of the satisfactory state of markets and of business in general.

Vessels under the British flag still far exceed, both in number and tonnage, those of any other nation. Although it cannot now be said that the United Kingdom is accountable for more than 50 per cent. of shipping at Antwerp, as it was a few years ago, nevertheless the British figures are not far short of half of the entire port returns. And this reduction, be it observed, is accounted for by an unusual increase in Belgian tonnage and not by a decline of British shipping. In point of fact the latter shows a large increase over the record figures of 1907, both in number of vessels and aggregate tonnage.

Next in importance comes Germany, which claims close on one-third of the port's shipping, so far as tonnage is concerned. But while a large number of British vessels make Antwerp their final port, thus bringing much trade to the city, many German vessels merely call to embark a few passengers and discharge and load little cargo.

Both the city and port of Antwerp are being enlarged, the extension of the former having been rendered possible by the dismantling of the fortified *enceinte* surrounding the town and its re-erection on a convenient system far beyond the present site. As for the pool, elaborate arrangements are in progress and are to be carried out as circumstances require. Two transverse basins and a portion of the new canal dock are undergoing construction; the former are estimated to be finished in about two years from the present date.

ARTS AND CRAFTS.

The Building Exhibition.—The Building Trades' Exhibition at Olympia is always an event of some interest from the point of view of applied art. No one who is well acquainted with the scope of the show expects to find there the *dernier cri* in the way of decoration and design, or to see the latest productions of the best known manufacturers displayed in large quantities; what one does look for, is an opportunity of seeing just the point at which the ordinary average taste of the community has arrived. The type of wall-coverings, tiles, leaded lights, distemper and enamel colours, and so forth, for which the middle-class customer all over the country is for the moment prepared to ask, and which the local builder and decorator has to supply, is very thoroughly exhibited. This year the prevailing note in design was a certain soberness. Excesses of all kinds were singularly absent, and one gained the impression that people are at present content with either small and rather inoffensive patterns, or with those which they consider securely "traditional" in character—copied from, or designed after the manner of, some well-known style. One rather daring playing-card frieze was shown, and some of the large patterns on black backgrounds were a trifle startling, but the exhibits of wall-papers and of wall-coverings of various kinds were on the whole safe rather than interesting. Stamped steel does not at first sight appear to lend itself very well to interior decoration, but some of the steleonite ceilings, cornices, etc., of the Emdeca Company were quite good in design, and suggest that if they were painted in more suitable colours they might be very useful for certain kinds of decoration work. There was a large show of tiling of all sorts and kinds. Some of the glass tiles now made in matt vitreous paste are produced in very good colours, and have a decidedly pleasant surface. The colouring is, of course, from the nature of the material, dumb rather than bright in quality, but for all that it is, in its own way, quite attractive. A good proportion of the rubber tile and mosaic flooring, too, is sufficiently agreeable to look at, and the shaped pieces of rubber fit well and closely together and make a floor-covering which is not only apparently incapable of harbouring dust, but is also peculiarly fit for ships, bathrooms, and other well-marked uses. A few of the brighter colours are sometimes more than a trifle crude, but they are at least pure and clean looking. Clay tiles were, for the most part, shown as adjuncts to the exhibits of the various stove and grate-makers, and took therefore the form of surrounds. The Well Fire and Foundry Company had a special display of their "Welft" decorated tiles, which were interesting on account of their singularly untilelike colour. The oranges and purples were distinctly suggestive of pigments not used as a rule in pottery decoration, and the semi-matt surface of the tiles added to their unusual appearance. One could not but think, however, that those on glaze colours were hardly adapted for their place, and would probably look shabby in a very short time. The designs, mainly rather small in scale, seemed to be applied by some stencil process. The simple arrangements of some of the Medenham tile panels were tasteful in a rather artless way, and there were some good panels of tiling on the lines of the old Persian work which looked like the work of the Pilkington Tile Company. The painted landscape tiles so commonly met with in surrounds some years back were conspicuous by their absence, and the tendency as a rule appears to be to frame up very simple panels for use at the sides of grates, or to employ richly-coloured plain tiles, or even allover patterns with no framing at all. The French tiles and specimens of the special Delft wall decoration, shown by the Bell Range and Foundry Company, were well worth looking at. Incidentally, it was satisfactory to note that the

lettering on the various stands was generally quite passable, and in some cases really good.

The Murray Bequest at the Victoria and Albert Museum.—The Murray Bequest, now on view at the Victoria and Albert Museum in what is officially called Room 100, but is probably much better known as one of the galleries of the old South Court, would probably have excited more interest had it not been somewhat overshadowed by the recent opening of the Salting Collection. The bequest includes, amongst other metalwork, a very interesting series of chalices, mainly Sienese and south Italian in type, a couple of good brass censers, two fine Chinese cloisonné vases, and some Italian, Sicilian, and Spanish peasant jewellery, fairly rough in workmanship, but vigorous and showing a strong family likeness. There is a collection of fans and fanmounts, and a few interesting bits of embroidery, notably an embroidered coat and a few embroidered Turkish towel-ends, eighteenth-century work, good both in colour and design. The little group of figures and vases from Meissen and other German factories, is also worthy of notice, and so are a few knives and the like with prettily inlaid handles. Altogether, though the bequest does not form a peculiarly homogeneous whole, it contains a large proportion of objects very well worth looking at. The news that £50,000 has also been left, the income from which is to be expended on the purchase of objects to be added to the collection, gives, perhaps, even greater cause for congratulation than the bequest of the collection as it stands.

EMPIRE NOTES.

The Imperial Conference.—After the Coronation of the King and Queen the most important Empire event for the year is the Imperial Conference, which is to be held in London this month. It is difficult to touch upon some of the subjects to be considered by the representatives of our Oversea Dominions without entering upon controversial matters. But there is one proposal which will be brought forward by Sir Joseph Ward, Prime Minister of New Zealand, which, it is anticipated, will, in principle, meet with the cordial approval of all. For a long time past, it has been the opinion of many of our colonial statesmen that there should be an Imperial Parliament, but although there may be much in favour of the idea, the times are not ripe for its realisation. However, the proposal that Sir Joseph will submit to the Conference may be regarded as the thin end of the wedge. It is to the effect that there should be an Imperial Council "with representatives from all constituent parts of the Empire, whether self-governing or not, in theory, and in fact, advisory to the Imperial Government on all questions affecting the interests of His Majesty's Dominions Oversea." Sir Joseph argues that this would lead towards fuller Imperial co-operation, while it would be quite consistent with the maintenance of the political autonomy of the various self-governing Dominions. The proposed Council, he considers, should be in a position to advise not only on matters of Imperial defence, but also on the commercial relations between the various parts of the Empire, and would have the advantage of affording to each part of the Empire the opportunity of expressing, through its representatives, its opinion on questions of Imperial interest.

British Investments in Canada.—The proposed Reciprocity Agreement between Canada and the United States has had the effect of calling attention to the amount of money invested by British capitalists in Canadian undertakings. Statistics show that close on £99,000,000 of British capital has been invested in Canada during the past five years. But, large as this sum is, there is every reason to believe that the supply of funds available for the further exploitation of the resources of the Dominion is by no means exhausted. It is asserted, in many quarters, that there is more money available for western Canada, at this moment, than ever previously. Canada is becoming a great magnet for investors, and the Western Provinces are recognised as affording some of the best opportunities for money-making in the world. A large number of new syndicates have been formed for development purposes, in the Prairie Provinces, during the last few months, and this in itself is strong evidence of the consistent popularity of western Canada as a field for investment.

The Development of New Quebec.—Many years ago the Canadian Geological Survey which explored the northern portion of the province of Quebec, intimated that the Huronian metalliferous formation extended far beyond the limits of Cobalt and Porcupine, and is not lost until it reaches far up into the unexplored wilds of Ungava. It pointed out that where this conglomerate rock is found all the precious and economic minerals are likely to occur, but practical men have been slow to follow up the suggestion then made. An important find, however, in northern Quebec made last autumn, in a small lake four miles long by half a mile wide —known to the Indians as Keekeek Lake—has attracted a good deal of attention. Here a quartz lode twenty feet wide, carrying very fine-grained gold was discovered. Claims were at once staked out, and now the whole surrounding territory is rapidly being taken up. If half the virtue which is claimed for this new field is proved, prospecting will, in all probability, be diverted from Porcupine to Keekeek. It is interesting to note in this connection that the Minister for Mines and Fisheries for Quebec has formed a campaign to draw the miners and prospectors into that province. The gold belt, twenty miles wide, extends from Lake Opasatika, where the Quebec Government has found tellurium, to Lake Missinable close to the trans-continental line. There appears to be little doubt as to the immense value of these auriferous deposits. The coming

season will, therefore, in all probability see the inauguration of a new Quebec, along the same line of latitude as New Ontario.

Canadian Flax for Irish Linen Manufacturers.—A letter was recently addressed to the Canadian Department of Agriculture, from a correspondent in Belfast, pointing out that Irish linen manufacturers are always looking for fresh sources of supply for the Irish markets. The present supply of flax fibre, used in the linen industry in Ireland, comes mainly from Russia, but there appears to be no reason why Canada should not provide fibre for that industry. The correspondent says:—"You grow for the seed alone, and burn the straw, but if we could get the fibre out of the straw at a fair price, it would be so much made money for your farmers. According to your statistics, the flax industry seems to be practically confined to Saskatchewan, which is so much in its favour, as it is more or less localised. My idea would be that the authorities in Saskatchewan and the railways should erect one or two mills for scutching as an experiment, and, should they prove paying concerns, others could be established afterwards. I should think the trade here would go to the expense of an instructor to give the thing a start off. The one thing certain is that there is a market here for your Canadian fibre if it can be had at a price, and anything at all is clear profit to the farmer." As the two provinces—Saskatchewan and Southern Alberta—had 476,877 acres under flax last year, the suggestion should commend itself to the Ministers of Agriculture for those provinces.

Electricity and Agriculture.—The use of electricity for agricultural purposes has been widely demonstrated in many parts of Europe and the British Empire, and Canada is anxious to prosecute the fullest inquiries into its adaptability to Canadian methods of farming. To carry out this idea, it is probable that the Ontario Government will despatch, this summer, two Commissioners to investigate the uses to which electricity is put in Europe. One of the representatives will be from the Hydro-Electric Commission, which has laid itself out to keep Canada abreast of all new electrical developments. The knowledge gained by the Commissioners will be utilised for public benefit. The proposed mission specially indicates a further and important development of the hydro-electric power project in the interests of agriculture.

Australian-Canadian Trade.—A deputation of the Melbourne Chamber of Commerce waited on the Minister of Customs for the Commonwealth recently, to urge upon the Government the desirability of taking action in the matter of reciprocity with Canada and the development of Australian-Canadian trade. This question had been brought before responsible Ministers many times before, and commercial men in Australia are coming to regard the question as one of very great importance. The Vice-President of the Chamber made the somewhat remarkable suggestion that Canada might be asked to defer the proposed reciprocity arrangement with the United States until the Commonwealth had had the opportunity of submitting a reciprocal proposal of its own to Canada. In responding to the deputation, the Minister said he would bring the matter under the notice of the Cabinet, but could give no assurance of anything immediate being done. He stated that the Imperial Conference was bound to consider reciprocity, but, with regard to the Canadian-United States treaty, interference on the part of Australia would not only be futile, but might possibly be resented.

The Commonwealth and its Silver Coinage.—The Australian Commonwealth Treasury Department recently published some figures which give an indication of the large amount of silver coin that is being circulated among the four and a half million people comprising the population of that country. A year ago an arrangement was made with the Imperial Mint, to the effect that Australia was to have the profit on its own silver coinage. An order was placed with the Home Government for £600,000 of new silver to be issued, and of this amount £392,000 has been placed in circulation within the Commonwealth. The manner in which this silver has been absorbed has struck the Treasury officials as being somewhat remarkable, as, although the additional coins in circulation number several millions, the currency has not been disturbed in any way. As a result of the ready absorption of the new issue, the Government has been unable to withdraw the £100,000 worth of old silver which it pledged itself to recall each year and to return to the British authorities. Up to the present time, only about one-fourth of that sum has been withdrawn. From the official standpoint, the coinage arrangement with the Home authority has proved most satisfactory, as by it Australia is making a large profit.

Australian Manufactures and British Manufacturers.—The various States of the Australian Commonwealth, since the beginning of the year, have been favoured with remarkably active markets in all classes of trade. This has been especially so in Victoria, where the Customs revenue has steadily expanded, and the movement appears likely to continue. There is said to be an exceptional opening for the establishment of factories in Australia at the present time, and manufacturers in this country, especially those who have hitherto been carrying on a profitable oversea business, will be well advised to examine closely the inducements offered to them to start factories of their own in that country. Among the inducements presented in the Commonwealth is the fact that there is practically an inexhaustible supply of coal and other minerals, the development of which only awaits the advent of the manufacturer and the capitalist. Further attention is drawn to the fact that it is the policy of the Government to encourage

local industries by means of protective duties, and, in some cases, by the payment of bounties and bonuses. Contracts, too, are frequently placed with local manufacturers at prices considerably higher than those which could be obtained for imported goods. Evidently there is a determination on the part of the Australian people to become, as far as possible, independent of the British, as well as the foreign, manufacturer. Statements of this kind, however disquieting in the interests of British trade, merit attention.

Natal Coal-fields.—For some time past there has been keen competition between Natal colliery owners and South African importers of Welsh coal, which, for many years, has held the mastery. There is evidence that at the present time, however, a change is taking place, for recently a statement of considerable interest to those connected with the coal industry was made before the Commercial and Industrial Commission sitting at Pietermaritzburg, to the effect that, for the majority of purposes, Natal coal had supplanted Welsh coal. In the agricultural industry, farmers who aforetime used Welsh coal, and that only for threshing, are now using the local coal. The quantity of imported coal going into Cape Town is computed at 6,000 tons per annum. It is now affirmed that the quantity of Natal coal used is more than that per month.

GENERAL NOTES.

The Wheat Industry of Manchuria.—The area of Manchuria is approximately 360,000 square miles, with an estimated population of ten to twelve millions. The present annual production of wheat is about ten million bushels, which might be increased to 300 or 400 million bushels, even with the primitive methods of native cultivation. The soil and climate are eminently favourable for wheat production. Of late years, there has been a noticeable growth in the consumption of wheat among the Chinese throughout China; and in Manchuria, in particular, a strong demand for wheat flour has arisen since the Russo-Japanese War. Flour is produced by steam roller-mills at Harbin, Changchun, Hailir, and Shuangchengpu under Russian management, at Ninguta, Aseho, and Kirin under Chinese management, and at Tiehling under Japanese management. In 1909, five million bushels of wheat passed into Harbin, of which over three millions were milled locally. The milling of wheat in Manchuria is increasing rapidly, and with cheap wheat, cheap labour, and low transportation charges, the Manchurian mills, with the steam mills at Shanghai, must inevitably capture the flour trade of the Far East.

New Port for Rome.—The Provincial Council of Rome have decided to apply to the Government for the necessary powers in order to construct a new port for the city. The locality, which has been selected after careful surveys, is at Palidoro, a small place on the coast 25 kilometres (15 miles) to the north-west of Rome, where traces of an ancient Etruscan harbour still exist. It is proposed to build two breakwaters, about 2,500 yards apart at their shore ends. The southern breakwater, which would be the longest, is to extend for about 1¼ miles into water 15 metres (about 8 fathoms) deep, and thence taking a west north-westerly direction for about 1¾ miles further, will overlap the entrance to the harbour by about 1,200 yards. The northern breakwater will run out from the shore in a parallel direction to the first for about a mile, and then, turning suddenly towards the other in a south-west direction, will leave an entrance to the harbour 300 yards wide, well protected from the Libeccio (south-west) winds. Inside the area thus enclosed will be constructed the necessary quays, etc., to which sufficient depth of water for vessels of large tonnage can be obtained by dredging. The cost of this work is estimated at 63 millions of lire (£2,520,000). The scheme also comprises the necessary sidings to connect the harbour with the existing railway at Palidoro station, also a direct line of railway, and a navigable canal to Rome.

Shale Oil Production in Australia.—Already about 1,000,000 gallons of oil from shale are being produced annually in Australia, and it is anticipated that during the course of the present year this output will be enormously increased, owing to the working of new fields and the installation of new and up-to-date machinery for treating the shale. About fourteen hundred tons of such machinery have been imported from England into New South Wales by one large company, which is already employing over a thousand men in the industry. While it is apparently much more expensive to extract oil from shale than to sink a bore and collect it as it flows, yet, as the shale is exposed, its extent and value can be estimated, which is impossible in the case of oil wells. The proved deposits of shale in Australia are so immense that they may be regarded as capable of supplying the Commonwealth with oil for centuries. Locally-manufactured kerosene from shale oil is now being used on the New South Wales State Railways, while benzine and motor spirit from the same source is being used in the motor trade, and there is also some local manufacture of candles from paraffin.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

May 17.—Professor Raoul Pictet, "Les Basses Températures."

May 24.—Frank M. Andrews, "Architecture in America." Sir Aston Webb, C.B., R.A., F.R.I.B.A., will preside.

Indian Section.

Thursday afternoon, at 4.30 o'clock:—

May 25.—W. R. H. Merk, C.S.I., LL.D., "The North-West Frontier Province of India." The Right Hon. the Earl of Minto, K.G., G.C.S.I., G.C.M.G., G.C.I.E., will preside.

Cantor Lectures.

Monday Evenings, at 8 o'clock:—

Alfred E. H. Tutton, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." Four Lectures.

Syllabus.

Lecture III.—May 15.—*Optical Evidence of the Two Complementarily Opposite (Mirror-image) Screw Structures.* Rotation of the Plane of Vibration of Polarized Light in Contrary Directions by the Two Varieties of Quartz—Experiments on the Artificial Reproduction of the Quartz Phenomena, in proof of the suggested Screw Structure—The Twinning of Quartz and Apparent Enhancement of the Symmetry and Destruction or Modification of the Optical Activity thereby—The Interesting Case of Amethyst—The Magnificent Polarization Phenomena of Twinned Quartz.

Lecture IV.—May 22.—*Scientific and Industrial Uses of Rock Crystal.* Its Thermal and Electric Properties, and its Transparency to Ultraviolet Rays—The Construction of Prisms and Lenses (including spectacles) of Rock Crystal, and their Advantages over Glass—The Use of Quartz for Balance Weights and in connection with the Interferometer—The Artistic Use of Quartz for the Carving of Vases and other Objects—Destruction of the Crystalline Structure by Fusion, and the Uses of Fused Silica in Fibres and Scientific Apparatus.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 15...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Dr. A. E. H. Tutton, "Rock Crystal: its Structure and Uses." (Lecture III.)

London Chamber of Commerce, Oxford-court, Cannon-street, E.C., 2.30 p.m. Señor Vicente Echeverria, "The Economic Resources of Chili."

Brewing, Institute of (London Section), Criterion Restaurant, Piccadilly, W., 8 p.m. Discussion to be opened by Mr. S. O. Nevile on "The Desirability of Applying Greater Technical Knowledge to the Cellar Management and Retailing of Beer."

Chemical Industries Exhibition, Agricultural Hall, Islington, N., 8 p.m. Dr. S. Rideal, "Modern Methods of Water Purification."

Tuesday, May 16...Statistical, at the Royal Society of Arts, John-street, Adelphi, W.C., 5 p.m. 1. Mr. H. D. Vigor, "On the Use of the 'Normal Crop' as a Standard in Crop Reports." 2. Mr. Frank Popplewell, "Seasonal Fluctuations in Employment in the Gas Industry."

Royal Institution, Albemarle-street, W., 3 p.m. Professor F. W. Mott, "The Brain and the Hand." (Lecture I.)

East India Association, Caxton Hall, Westminster, S.W., 4 p.m. Mr. J. Begg, "The Architect in India."

Chemical Industries Exhibition, Agricultural Hall, Islington, N., 8 p.m. The Earl of Denbigh, "Beet-root-Sugar."

Wednesday, May 17...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Professor Raoul Pictet, "Les Basses Températures."

Meteorological, 70, Victoria-street, S.W., 4 p.m. 1. Dr. Hugh Robert Mill and Mr. C. Salter, "On the Frequency and Grouping of Wet Days in London." 2. Mr. E. Mawley, "Report on the Phenological Observations for 1910."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. J. E. Barnard, "A Method of Disintegrating Bacteria and other Organic Cells." 2. Mr. T. W. Butcher, "Structural Details of *Coscinodiscus asteromphalus.*"

Concrete Institute, 296, Vauxhall-bridge-road, S.W., 5.45 p.m. Mr. R. W. Vawdrey, "Reinforced-Concrete." (Lecture IV.)

Royal Society of Literature, 20, Hanover-square, W., 5 p.m. Count Lützow, "The Apostles of Moravia and Bohemia."

Chemical Industries Exhibition, Agricultural Hall, Islington, N., 8 p.m. Dr. W. P. Dreaper, "Artificial Silks and Fibres."

Thursday, May 18...Chemical Industries Exhibition, Agricultural Hall, Islington, N., 8 p.m. Mr. J. C. Smith, "Protection of Structural Iron and Steel."

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Philatelic, 4, Southampton-row, W.C., 6 p.m. Mr. R. B. Yardley, "The Stamps of South Australia, with Notes on Same."

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs W. F. Cooper and W. H. Nuttall, "Some Reactions of ω-brom-methyl-furfuraldehyde." 2. Messrs. W. N. Hartley and C. H. Little, "The Course of Chemical Change in Quinol under the Action of Radiant Energy." 3. Mr. H. E. Watson, "A Method for the Accurate Volumetric Determination of the Oxygen in the Air." 4. Mr. H. D. Law, "Electrolytic Reduction. IV. Aromatic Aldehydes."

London Chamber of Commerce, Oxford-court, Cannon-street, E.C., 2.30 p.m. Mr. F. Faithfull Begg, "The Telephone: State Monopoly and Popular Control."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. N. Shaw, "Air and the Flying-Machine: The Structure of the Atmosphere and the Texture of Air Currents." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Professor Pope, "Some Scientific Applications of Photo-Micrography in Natural Colours."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Mr. W. Aitken, "Automatic Telephone-Exchange Systems."

Historical, 7, South-square, Gray's Inn, W.C., 5 p.m. Mr. C. H. Jenkinson, "The Records of the African Slave Trade."

Numismatic, 22, Albemarle-street, W., 6.30 p.m. Mr. G. C. Brooke, "Notes on the Reign of William I."

Friday, May 19...Chemical Industries Exhibition, Agricultural Hall, Islington, N., 4.30 p.m. Dr. H. P. Stevens and Mr. Clayton Beadle, "India-Rubber."

Royal Institution, Albemarle-street W., 9 p.m. Professor R. W. Wood, "Recent Experiments with Invisible Light."

Kite and Model Aeroplane Association, Northampton Institute, Clerkenwell, E.C., 8 p.m. Mr. S. F. Cody, "How I Learnt to Fly."

Saturday, May 20...Chemical Industries Exhibition, Agricultural Hall, Islington, N., 8 p.m. Mr. J. A. Weil, "Gas-Producers."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. P. Pycraft, "Phases of Bird Life: Flight." (Lecture I.)

National Housing and Town Planning Council, at the Royal Society of Arts, John-street, Adelphi, W.C. Conference on Town Planning.

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FRIDAY, MAY 19, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MAY 22ND, 8 p.m. (Cantor Lecture.) ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal: its Structure and Uses." (Lecture IV.)

WEDNESDAY, MAY 24TH, 8 p.m. (Ordinary Meeting.) FRANK M. ANDREWS, "Architecture in America." Sir ASTON WEBB, C.B., R.A., will preside.

THURSDAY, MAY 25TH, 4.30 p.m. (Indian Section.) W. R. H. MERK, C.S.I., LL.D., "The North-West Frontier Province of India." The Right Hon. the EARL OF MINTO, K.G., G.C.S.I., G.C.M.G., G.C.I.E., will preside.

CANTOR LECTURE.

On Monday Evening, May 15th, Dr. ALFRED E. H. TUTTON, M.A., F.R.S., delivered the third lecture of his course on "Rock Crystal: its Structure and Uses."

The lectures will be published in the *Journal* during the summer recess.

EXAMINATION FRAUDS.

On pp. 703-6 there appears a full report of the cases tried on Saturday, May 13th, at Bow-street, in which two teachers were convicted, on their own confession, of having improperly obtained certain money prizes and medals at the Society's Examinations.

CONVERSAZIONE.

The Society's Conversazione will be held, by permission of the Trustees of the British Museum, in the Galleries of the Natural History Museum, South Kensington, on Tuesday Evening, May 30th, from 9 p.m. to 12.

The Reception, by Sir JOHN CAMERON LAMB, C.B., C.M.G., Chairman, and the other Members of the Council, will be held in the Central Hall from 9 to 10 p.m.

A Selection of Music will be performed by the Band of H.M. Royal Artillery, in the Central Hall, commencing at 9 o'clock.

A Vocal and Instrumental Concert will be given in the Fish Gallery and a Miscellaneous Entertainment in the Shell Gallery, under the direction of Mr. PATRICK KIRWAN, commencing at 9.30 p.m.

The following portions of the Museum will be open:—

The Central Hall, containing cases of specimens illustrating Mimicry; Adaptation of Colour to surrounding conditions; Protective Resemblance; etc. Also specimens illustrating the Food of Fishes, and the Life History of the Eel (East of staircase).

The North Hall, containing the collection of Domesticated Animals.

The Bird Gallery, containing groups of British Birds and Nests; and in the Pavilion, at the West end, an exhibition of the Land and Fresh-water Vertebrate Animals of the British Isles.

The Fish Gallery, containing the Great Basking Shark, the grotesque Deep-sea Fishes (case 44), the Tunny (case 38), the Tarpon and Angler-fish (case 27), and the Lemon-Sole (case 30), etc.

The Shell Gallery, including a life-size model of a Giant Squid (Newfoundland), and of a Giant Octopus (California).

The East and West Corridors on the First Floor, containing the Okapi, African Antelopes, and Giraffes.

Light Refreshments will be supplied at Buffets in the North and South Corridors on the First Floor of the Museum, and at the end of the Bird Gallery.

Visitors travelling by the District Railway (or other underground railways in connection

therewith) will be allowed free use of the company's subway, which leads from South Kensington Station direct into the grounds of the Museum.

Each member is entitled to a card for himself (which will not be transferable) and a card for a lady. (These cards have now been issued.) In addition to this, a limited number of Tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5*s.* each, if purchased before the day of the Conversazione. On that day the price will be raised to 7*s.* 6*d.*

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary at the Offices of the Society, John-street, Adelphi, W.C. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

The Council reserve the right of stopping the sale of tickets or of raising the price, if it is found necessary, in order to restrict the number of visitors within reasonable limits.

Further particulars as to the musical and other arrangements will be given in the Programmes, which will be distributed on the evening.

PROCEEDINGS OF THE SOCIETY.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 17th, 1911; Sir JOHN CAMERON LAMB, C.B., C.M.G., Vice-President and Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Broderick, John Carroll, 15, St. James-street, Montreal, Canada.

Craig, Eustace N., Messrs. D. & C. Rutter, Ltd., Crayford, Kent.

Hirata, Tomoh, Consulate-General of Japan, 3, Alipore-lane, Calcutta, India.

Keatinge, Sherbrooke Augustus John, M.I.Mech.E., Vineholt, Abbott-road, Lahore, India.

Ross, Alexander Carnegie, C.B., M.A., British Consulate, Buenos Aires, Argentine Republic, South America.

Subhan, Nawabzada A. K. M. Abdus, Khan Bahadur, Senior Deputy-Magistrate and Collector, Furudpore, E.B.A., India.

The following candidate was balloted for and duly elected a member of the Society:—

Beg, Mirza Faiz Husain, Kothi M. Abbas Beg, Kaiserbagh, Lucknow, Oudh, India.

The CHAIRMAN, in introducing the lecturer for the evening, said that in the year 1897 Professor Ewing delivered a series of lectures before the Society on the mechanical production of cold. In one of these he described the refrigerating machine known as the sulphurous acid machine, which was introduced by M. Pictet in 1875. In another lecture of the series, dealing with very low temperatures, and with the liquefaction of gases, he referred to the work of M. Pictet in that field in the following terms: "The attention of the scientific world was arrested in the beginning of the year 1878 by the news which reached it almost simultaneously from two sources, that two independent experimentalists had succeeded in liquefying certain of the so-called permanent gases, which had been left unliquefied in the earlier experiments of Faraday. Cailletet and Pictet, within a few days of one another, but independently, and by more or less distinct methods, succeeded in liquefying oxygen, nitrogen, and other gases. Pictet employed what we may distinguish as the cascade or successive cycle method." Professor Ewing then proceeded to describe this method, in words which it was unnecessary to repeat at that meeting. It had been necessary to wait a long time for M. Pictet himself to visit the Society, but he (the speaker) was sure those present would join in extending to him a very hearty welcome, and assuring him that his lecture would be listened to with much pleasure.

The paper read was—

LES BASSES TEMPÉRATURES.

Par M. le Professeur RAOUL PICTET.

Voici déjà plusieurs années que vous m'avez fait le grand honneur de me nommer comme membre étranger, faisant partie de votre illustre société! C'est donc avec une joie sincère que je peux aujourd'hui me présenter à vous et vous remercier personnellement de cet honneur que dans votre pensée vous avez fait autant à mon pays, à la Suisse, que vous aimez tous et depuis si longtemps, qu'à un pauvre travailleur que vous avez voulu encourager par vos suffrages tout en saluant son pays d'origine.

Merci, chers collègues, merci pour l'Helvétie, merci pour ma famille, dont un membre, Marc Auguste Pictet en fondant la Revue Britannique, fut mon parrain d'origine près de vous.

En entrant dans cette salle où vous m'accueillez avec cette vive sympathie, je sens toute ma jeunesse revivre en souvenirs charmants.

Dès mes premières leçons de physique et tout spécialement de thermodynamique je revois les figures vivantes de mes maîtres : Kelvin, professeur alors à Glasgow, Clerk-Maxwell, Tyndall, Crookes et tant d'autres dont les travaux ont été notre pain quotidien.

En 1868 je travaillais la théorie générale des machines frigorifiques à l'École Polytechnique de Paris, ce fut Lord Kelvin qui, recevant la lettre d'un simple étudiant d'école, me répondit par un vrai mémoire, approuvant mes déductions et m'encourageant à poursuivre.

Plus tard en 1876, dans l'inoubliable exposition des instruments historiques de physique, je fus reçu par cette pléiade d'hommes admirables tant par leur prodigieuse érudition que par cette affabilité légendaire et superbe dont je retrouve ici l'écho. Nommer toutes ces figures disparues hélas, serait refaire le palmarès de la vie scientifique du monde ! Vous comprenez donc, chers collègues, la joie que j'éprouve à venir vous dire merci, à serrer vos mains amies et à continuer selon mes faibles moyens cette longue tradition de rapports intellectuels qui lie depuis plusieurs siècles notre vieille Genève à la vieille Angleterre.

Et maintenant j'aborde le sujet qui depuis quarante années fait l'objet assidu de mes pensées ; je l'ai choisi à la suggestion de votre aimable secrétaire, et je l'ai accepté d'autant plus volontiers que vous entendrez dans mon exposé le "Leitmotiv" de ma vie scientifique.

Nous sommes des êtres sensitifs, pensants et qui traversons la vie avec un voile éternel devant les yeux.

Ah, connaître les choses et la raison des choses ! Associer les phénomènes révélés par l'observation, les rassembler méthodiquement, essayer de deviner l'intelligence suprême qui les a conçus, balbutier une première explication, la vérifier, constater ses erreurs, revenir en arrière, transformer les hypothèses et les redresser, recommencer la question à la Nature par de nouvelles expériences mieux disposées ; se rapprocher du but, se sentir émotionner par l'approche de parcelles de vérité et enfin avoir l'extase de quelques principes arrachés à la pensée divine, voilà le programme toujours neuf, toujours grandiose, toujours beau de la vie de notre pauvre intelligence, boiteuse, incomplète, chétive et qui rappelle dans ses élans si purs, si nobles et désintéressés la légende du "vermisseau amoureux d'une étoile."

C'est donc par l'hypothèse que notre âme tâtonne, cherche son chemin et règle la discipline de l'expérience. L'hypothèse a pour définition : "Le Roman scientifique."

En effet, l'hypothèse est un travail d'imagination. On n'observe pas une hypothèse, on la crée. Ces enfants intellectuels ont un état civil spontané, et de plus les parents, ou pour mieux dire, le père, doit être sans pitié pour sa progéniture.

Il doit exécuter sans merci toute hypothèse qui n'est pas confirmée par les faits, tirés d'expériences spéciales, cruciales, destinés à comparer les résultats découlant théoriquement de l'hypothèse de ceux qui fournissent les expériences directes observés dans le but unique de contrôle.

Or l'Univers nous montre cinq modes de phénomènes ayant des caractères bien différents et pour ainsi dire inconciliables ; les voici :

1° Les phénomènes astronomiques ;
2° Les phénomènes physiques ;
3° Les phénomènes chimiques ;
4° Les phénomènes vitaux ;
5° Les phénomènes psychiques.

L'homme d'aujourd'hui possède des bibliothèques entières nous renseignant assez exactement sur la nature concrète de ces différents modes de l'ensemble des phénomènes naturels.

La question donc que chacun de nous se pose tout naturellement est celle-ci :

Quels sont les liens communs qui peuvent réunir ces cinq modes de phénomènes divers ?

Découlent-ils tous de principes absolument différents ?

Sont-ils liés par des lois d'évolution?

La mécanique rationnelle peut-elle concevoir une hypothèse réunissant cet immense ensemble de faits ?

La question posée dès l'âge d'homme dans ma pensée, je l'ai constamment entretenue pendant les expériences ininterrompues de près de quarante ans et je veux apporter ici, très modestement, un essai de synthèse des phénomènes naturels. J'ai été dirigé dans ce travail de longue haleine par une boussole dont le pôle est le suivant :

Ne rien imaginer comme cause de mouvement que le phénomène général de l'attraction.

Ne pas accepter de forces répulsives.

Ne pas accepter de matière qui n'ait comme propriétés essentielles autre chose que :

1° Un volume dans l'espace ;
2° Une certaine résistance pour prendre du mouvement, appelée inertie ;
3° Une propriété attirante, agissant sur les matières environnantes, cause du mouvement.

Ces bases d'hypothèse m'ont paru simples, nettes et compréhensibles à tous.

Elles sont aussi les bases de la mécanique rationnelle. Nous devons donc expliquer l'ensemble des phénomènes cosmiques uniquement par des éléments tirés de la mécanique rationnelle sans aucune addition. Chaque mot employé doit être clairement défini et compris.

C'est en exécutant le programme des vérifications de cette hypothèse d'ensemble que le rôle obligatoire des basses températures m'est apparu.

C'est par les basses températures et leur emploi méthodique que les vérifications sont possibles.

Permettez-moi donc maintenant, chers collègues, d'entrer dans le vif du problème et de commencer mes démonstrations.

Je vous présenterai deux expériences en projection comme appui de mes déductions théoriques, je dois donc résumer autant que possible mon exposé pour ne pas être trop long.

I.

Je ne puis, dans le peu d'instants qui nous réunissent, vous faire un exposé complet d'une question si grave et si riche de faits et de développements de toutes natures. Je tiens seulement à vous exposer rapidement une série de jalons qui permettent actuellement de jeter des ponts entre les diverses branches des sciences physiques et font jouer aux basses températures un rôle d'une importance de plus en plus grande.

L'essai d'une méthode générale de synthèse cosmique que nous esquissons dans cette conférence, est basé entièrement sur une conception mécanique de tous les phénomènes de la nature, y compris la vie végétative. Lorsque les équations de l'astronomie, ou plutôt les fonctions générales de l'attraction universelle, exprimées pour toutes les distances, donneront une explication rationnelle de la physique et de la chimie, on pourra calculer une réaction comme on prévoit une éclipse; on déterminera une tension maximum de vapeur comme une chaleur latente, etc., ce seront des phénomènes du même ordre. La mécanique rationnelle deviendra la science universelle.

Ce résultat est le but qui ne sera probablement atteint que dans les siècles futurs; maintenant, il faut surtout préciser le problème et éviter toutes les équivoques en employant un langage précis dont chaque terme soit complètement défini.

La première difficulté très grande qui s'est présentée et qui, aujourd'hui encore, est un terrain de combat, c'est la terminologie employée dans la science actuelle pour exprimer les phénomènes. En mécanique nous avons trois unités si claires, si précises qu'elles peuvent servir sans aucune crainte d'erreur ou de confusion à exprimer tous les mouvements: l'espace, l'effort musculaire, le temps.

En combinant l'espace avec l'effort on arrive à la notion du travail mécanique. En combinant l'espace avec le temps on acquiert la notion de vitesse. En combinant la vitesse des corps, observée sous l'influence des efforts ou des forces, on obtient la notion expérimentale de la masse des corps. Et c'est tout! La mécanique n'emploie pas d'autres unités, c'est ce qui fait sa puissance, sa clarté infinie! Nous sentons dans tout notre être la mécanique par le jeu musculaire volontaire de notre corps. La conception de tous les éléments du calcul astronomique, en mécanique, se ramène en dernière analyse à des impressions sensorielles communes à tous les hommes et sur lesquelles, à l'exception de beaucoup d'autres, ils sont tous d'accord: la conscience de l'effort.

Mais en physique et en chimie, quelle confusion! Nous trouvons la température, la calorie, la conductibilité, la cohésion, l'affinité, les chaleurs latentes, les chaleurs spécifiques, etc. Tout cela doit se ramener aux trois facteurs primordiaux: espace, force, temps, et à leurs dérivés immédiats, travail, vitesse, masse. Sinon, pas de physique ni de chimie mécaniques. C'est là l'objectif actuel de la thermodynamique et de la dynamochimie.

Nous commencerons l'étude qui va nous occuper en montrant que la physique et la chimie, et tout particulièrement la chimie, ont trouvé dans la thermodynamique des facteurs puissants de développement par la production artificielle et l'utilisation des basses températures. On peut dire que dans cette direction la théorie pure et l'appareil lui-même s'unissent intimement pour constituer un domaine spécial du plus haut intérêt. Nous tâcherons de montrer le rôle caractéristique que jouent les basses températures pour hâter la solution des problèmes posés dans le sens où nous venons de l'indiquer dans cette introduction et nous partirons de là pour fonder une méthode générale de synthèse chimique.

Et d'abord, quelle est la définition de la température? A l'origine, le tact de la main était le seul thermomètre connu. Suivant les impressions perçues on disait: froid, tiède, chaud, brûlant! Comme on dit d'un tableau, il est laid, médiocre, superbe! Mesurer la température était autrefois un travail psychique

analogue à la mesure de la beauté : on appréciait une sensation.

Or, d'après ce que nous avons dit, il faut à tout prix ramener la notion de température aux éléments mécaniques, et s'arranger de telle sorte que ce soit le système musculaire du bras, et plus le tact de la main, qui mesure les températures. Pour cette partie du problème, on peut la considérer comme résolue. A l'inverse de la beauté (qui restera, heureusement, toujours inaccessible à la mécanique, précieux apanage des fonctions esthétiques de l'âme) la température est mesurable en faisant complètement abstraction des impressions tactiles. Ici nous devons entrer à pleines voiles dans les hypothèses nécessaires sur la constitution des corps et les mouvements calorifiques.

Nous admettons que les corps sont composés d'une infinie quantité de petites masses de matière appelée atomes ou molécules, suivant leur plus ou moins grande complexité. Chaque atome et molécule est noyé dans l'éther, fluide sans masse appréciable, mais parfaitement élastique et attiré fortement par la matière. La matière attire la matière suivant la fonction newtonienne, corrigée pour les distances très petites ; donc les atomes et les molécules s'attirent les uns les autres. Ils arriveraient au contact parfait si un conflit ne surgissait pas entre l'attraction de la matière pour l'éther, et celle de la matière pour la matière.

En admettant avec Lamé et d'autres auteurs que la fonction d'attraction croisse plus vite dans l'attraction de la matière pour l'éther, que por la fonction newtonienne, il résulte que deux parties constituantes d'un corps ne se toucheront pas, mais resteront en équilibre stable à une certaine distance déterminée qui ne se modifiera jamais par l'action seule de la force d'attraction. Pour bien faire entendre ce point capital dans cette théorie, imaginons, dans les espaces sidéraux supposés vides de toute autre matière pondérable, deux atomes libres de leurs mouvements et chutant l'un sur l'autre, retenus par deux dynamomètres très sensibles qui mesurent à chaque instant la force d'attraction de ces deux atomes pendant qu'ils se rapprochent : à l'infini les attractions seraient nulles ou presque nulles ; les distances deviennent-elles progressivement plus petites, les attractions croissent en raison inverse du carré des distances, la fonction newtonienne pure peut s'appliquer ; les distances sont-elles très petites, le conflit des deux attractions se fait sentir, l'effet de l'éther s'oppose à l'attraction dans le voisinage de la position d'équilibre stable ; enfin, arrivés à cette distance limite, les deux atomes seraient abandonnés sans choc par les deux dynamomètres, lesquels seraient au zéro indiquant un effort d'attraction nul. En chutant l'un sur l'autre de l'infini, distance au départ, à cette position limite voisine du contact, ces deux atomes auraient épuisé complètement leur capital d'attraction, soit leur potentiel, pour employer le mot exprimant cette notion. Ils seraient incapables de produire aucun mouvement puisqu'ils ne seraient plus sollicités par aucune force dans aucune direction.

Imaginons donc un corps constitué par l'agglomération de quelques milliards d'atomes, tous réunis ensemble dans cette position d'équilibre finale, nous aurons ainsi une masse matérielle dépourvue de tout mouvement, incapable d'en produire et représentant la mort aussi exactement que notre imagination peut se la figurer. Ce corps inerte sera au zéro absolu des températures, il sera infiniment froid. Vient-on à communiquer à ce corps de l'énergie sous une forme quelconque, en le frappant par exemple, aussitôt les parties constituantes quitteront la position d'équilibre qu'elles occupaient et se mettront à osciller autour de cette position d'équilibre ; tantôt elles se rapprocheront davantage et seront alors repoussées par l'action prépondérante de l'éther, tantôt elles s'écarteront les unes des autres et leur attraction réciproque les ramènera vers leur position d'équilibre. Nous voyons très clairement ce mouvement oscillatoire s'établir et représenter l'équivalence mécanique de l'énergie cédée au corps.

Il est clair que le centre de gravité du corps est resté immobile ; sans cela une partie de l'énergie fournie au corps se serait transformée en mouvement de translation qui rentrerait dans l'étude de la balistique et non plus dans la thermodynamique.

Nous ne nous occupons donc que des mouvements oscillatoires et ce sont eux qui vont nous fournir les définitions rationnelles de la terminologie employée en thermodynamique.

Nous avons dit en effet que nous devons ramener tous les termes sans exception aux six facteurs de la mécanique rationnelle ; les mots température, chaleur, chaleur spécifique, chaleur latente, etc., doivent donc être des dérivés directs de l'espace, de la force et du temps, combinés sous toutes les formes possibles.

Le mouvement oscillatoire que nous avons décrit comme devant être le résultat nécessaire de la transformation de l'énergie dans le corps considéré, nous fournit deux facteurs immédiats :

l'amplitude de l'oscillation, puis la force moyenne qu'indiquerait le dynamomètre si on le promenait le long de "l'orbite moléculaire" décrite par chaque particule en retenant la molécule dans sa course.

Le produit des chemins parcourus par l'attraction correspondante représente le travail en kilogrammètres accumulé par le mouvement oscillatoire de chaque molécule dans sa masse. En somme, il faut intégrer le produit des chemins parcourus par l'attraction correspondante exprimée en fonction des mêmes positions dans l'espace, faire cette intégration pour chaque molécule, faire ensuite la somme des éléments du travail pour avoir l'énergie totale actuelle du corps.

Le calcul ainsi fait se ramène aux équations de la mécanique céleste.

Appelons donc par définition :

1° Température : L'amplitude moyenne des oscillations vibratoires (projection de l'orbite moléculaire sur les trois axes).

2° Chaleur spécifique : l'attraction moyenne du corps sur la molécule considérée à un moment quelconque.

Nous aurons comme conséquences immédiates les autres définitions suivantes :

3° Quantité de chaleur. Produit de la température (espace parcouru) par la chaleur spécifique (force moyenne agissant sur l'espace parcouru) ou quantité d'énergie actuelle d'un corps.

4° La température est donc proportionnelle à la force vive des molécules d'un corps.

5° Le poids atomique de la plus petite particule du corps, servira au calcul des masses, des forces vives et des vitesses.

6° L'augmentation du volume apparent d'un corps, soit sa dilatation, servira pour mesurer une valeur approchée de sa température et de la quantité de chaleur qu'il contient, etc.

Nous n'indiquons ici qu'une partie des déductions immédiates qui se dégagent de ces hypothèses sur la constitution des corps, renvoyant pour plus de détails à un mémoire paru il y a déjà trente-deux ans sur la "synthèse de la chaleur." *

Qu'il suffise de rappeler ici que toutes les lois connues en thermodynamique se déduisent aisément des conditions initiales admises par cette hypothèse, ainsi que des définitions établies.

Plusieurs lois concernant des rapports simples entre les températures de fusion des corps, les poids atomiques, les densités, les coefficients de dilatation ont été d'abord déduites par le calcul, puis vérifiées expérimentalement plus tard. Nous appuyons sur ce point car ainsi qu'on va le voir, ce sont les mêmes idées, les mêmes hypothèses qui vont tracer les grandes lignes du rôle des basses températures en science et particulièrement en chimie.

Pour bien faire entendre ces points qui commandent toute cette étude, nous devons dès maintenant établir les démarcations essentielles qui séparent la physique de la chimie au point de vue mécanique. Lorsque ces différences fondamentales seront saisies, les rapports entre ces deux sciences jumelles n'en deviendront que plus lumineux et l'on verra que la même mécanique les embrasse et les confond dans les mêmes équations.

Reprenons pour un instant la formation d'un corps quelconque par la juxtaposition de ses éléments constitutifs tels qu'ils sont connus actuellement en chimie. Prenons 1 kilogramme de soufre par exemple. Nous ferons tomber des espaces sidéraux en un point quelconque la totalité des éléments atomiques appelés soufre et dont la masse totale correspond à celle de 1 kilogramme. Ces éléments transforment en travail de chute la totalité de leur potentiel et l'on obtient 1 kilogramme de soufre au zéro absolu de température. Faisons de même pour 1 kilogramme d'oxygène qui nous fournira, au zéro absolu, un autre corps absolument inerte mais ayant la même masse : celle de 1 kilogramme. Dans ces deux cas nous n'avons mis en activité que des potentiels physiques, c'est-à-dire des attractions qui s'exercent entre les particules ayant la même constitution intérieure. Une molécule de soufre attire une molécule de soufre, puis une autre et ainsi de suite.

De même une molécule d'oxygène attire une autre molécule d'oxygène jusqu'à l'épuisement de 1 kilogramme, somme totale du corps.

Dans ces phénomènes d'attraction l'ordre dans lequel chaque molécule vient prendre son rang n'a aucune importance, puisque toutes les molécules sont identiques entre elles.

Donc, dans tous les phénomènes physiques la répartition topographique des divers atomes d'un même corps entre eux est réglée par la pression extérieure et par la température uniquement. L'interchangeabilité de ces atomes supprime tout effet quant à leur ordre de marche sur le centre d'attraction.

Les phénomènes de condensation de l'état gazeux à l'état liquide, de l'état liquide à l'état solide, la cristallisation de tous les corps, sont le résultat de la cohésion, force qui représente

* Voir "Synthèse de la Chaleur." Archives des Sciences phys. et nat., octobre, 1879.

en physique moléculaire, la gravitation dans la mécanique céleste.

Un tout autre phénomène se passe lorsqu'une masse d'oxygène se trouve en présence d'une masse de soufre, les deux éléments en présence sont hétérogènes et le potentiel mis en activité est le potentiel d'attraction chimique ou de l'affinité.

L'expérience enseigne que les phénomènes chimiques se produisent dans des conditions tout autres :

La " condensation " du soufre avec l'oxygène exige une proportion définie dans les masses en présence.

Elle exige aussi une certaine température initiale.

Elle peut se faire entre les deux mêmes corps en plusieurs proportions et les masses engagées dans chaque combinaison sont des multiples exacts des masses premières.

Les pouvoirs d'attraction se modifient puissamment selon le degré de combinaison déjà réalisé par un corps. En reprenant notre exemple des deux masses d'oxygène et de soufre en présence au zéro absolu et en mettant ces corps au contact, on constate que, même pressés l'un contre l'autre fortement et chauffés, il faut élever très fortement la température pour que la combinaison, ou la chute chimique, de l'oxygène sur le soufre commence.

On observe en même temps deux faits :

La quantité de chaleur dégagée par le potentiel chimique pendant la réaction est très supérieure à la quantité de chaleur dégagée par le même poids d'oxygène seul condensé, plus la quantité de chaleur que fournirait la condensation du poids du soufre engagé dans la réaction. En outre l'oxygène d'une part, le soufre de l'autre, se condensent tous deux sous l'effet de températures inférieures à celle qui est nécessaire à la combinaison des deux éléments.

Il nous faut mettre ce paradoxe bien en lumière :

Puisque un certain poids de soufre en s'unissant à un certain poids d'oxygène produit plus de chaleur que la condensation des deux composants, il faut nécessairement admettre que le potentiel chimique dans ce cas est plus puissant que le potentiel physique des deux masses et pourtant la cohésion opère à une température où l'affinité des deux mêmes corps, plus puissante, ne peut produire aucun phénomène ? Comment expliquer cela ? Traduisons ce paradoxe suivant nos définitions adoptées. Un poids A d'oxygène, séparé d'un autre poids A d'oxygène par une autre distance 1, correspondant à la longueur de l'oscillation calorifique due à la température t s'associe par cohésion à cette molécule.

Ce même poids A d'oxygène attirant une masse B de soufre avec une affinité plus puissante que la cohésion de A pour A et maintenue à la même distance 1, due à la température t, ne s'associe pas au soufre. On doit élever la température, augmenter la distance moyenne de 1, et tout à coup la réunion de A B s'effectue !

En outre la réaction est très modifiable suivant les masses d'oxygène et de soufre en présence et suivant la présence d'autres corps au moment de la réaction, de l'eau par exemple.

Dans toutes les réactions chimiques, la disposition topographique des molécules entre elles, la manière dont elles sont mécaniquement apportées les unes dans le voisinage des autres, tous ces facteurs prennent une influence prépondérante sur l'issue finale de la réaction.

Ici l'interchangeabilité des atomes a disparu, il faut qu'ils se présentent à l'appel des forces d'attractions dans un ordre précis.

Toute la chimie est la constatation de ces faits généraux. Nous devons donc voir comment une hypothèse mécanique peut rendre compte de ces faits en apparence inconciliables. Cette hypothèse trouvée nous guidera ensuite dans les expériences à entreprendre comme vérification puis nous mènera après sur une piste nouvelle d'investigations.

C'est là le programme que nous allons suivre.

II.

La question posée est celle-ci: si les hypothèses physiques sur la constitution des corps, exposées dans le chapitre précédent, permettent d'envisager comme réalisable et réalisée en partie la transformation de la physique en astronomie moléculaire, quel changement doit-on y apporter pour faire rentrer dans ces mêmes hypothèses les phénomènes chimiques ?

Voici ce qu'on peut admettre comme hypothèse générale: les corps se constituent sous leurs trois états ainsi qu'il a été exposé, mais tant que le corps reste semblable à lui-même, les distances entre les centres des molécules qui s'attirent restent relativement grandes.

Met-on en présence deux corps hétérogènes, ce sont centres eux-mêmes d'attraction qui sont modifiés, ce qui oblige le corps nouveau à pénétrer profondément jusqu'au milieu de la molécule.

Pour bien comprendre cette hypothèse, grossissons plusieurs millions de fois les phénomènes moléculaires physiques et chimiques, que verra-t-on ? Des cellules organiques !

L'agglomération des cellules contigues semblables entre elles constituent les tissus, chaque cellule a son nucleus et son protoplasma qui, d'une façon très éloignée, représenterait la sphère d'éther entourant le nucleus. Le phénomène chimique correspondrait au phénomène de l' "hémogenie" ou de la fécondation cellulaire si remarquablement étudié ces dernières années par MM. Fol et Camille Pictet. Un zoosperme pénètre au travers du protoplasma de la cellule et marchant à la rencontre du nucleus, se soude avec lui pour donner naissance à l'être nouveau.

Il est clair que cette comparaison n'est qu'une grossière image du phénomène chimique primitif; elle ne sert qu'à faire saisir l'ensemble des mouvements mécaniques accomplis et la différence fondamentale entre les effets de la cohésion, réunissant entre elles les éléments identiques, et ceux de l'affinité, faisant pénétrer au centre même attractif l'atome hétérogène.

Cette pénétration dans le centre de la molécule de l'atome de l'autre corps se fera-t-elle d'une façon continue depuis les grandes distances à l'origine du mouvement jusqu'au moment de la réaction chimique? L'expérience a montré que ce n'est pas le cas. On peut mettre en contact les corps jouissant d'une grande affinité l'un pour l'autre et cependant la réaction ne s'effectue pas. Nous admettons donc dans notre hypothèse que l'affinité n'est que la continuation de la cohésion lorsque les distances deviennent encore beaucoup plus petites entre les centres qui s'attirent; c'est la valeur newtonienne de la gravitation quand la distance converge vers 0.

Dans cette hypothèse on comprend ce qui se passe pendant le trajet de chute de deux atomes hétérogènes l'un sur l'autre. Ils commencent par se rapprocher jusqu'à se trouver aussi voisins que possible; retenus à distance lorsqu'ils passent à la première limite imposée à la cohésion. Ils agissent dans cette première phase comme des corps identiques et non hétérogènes. Pour les faire passer dans la seconde période, celle de l'affinité, il faut les faire pénétrer de force dans la sphère d'éther. Alors arrivé à une certaine profondeur on observera deux phénomènes. 1° L'affinité se manifestera avec intensité à cause du plus grand réapprochement des deux centres d'attraction, et 2° la réaction de l'éther sur le corps pénétrant diminuera de toute la valeur attractive des couches pénétrées d'une façon analogue à ce qui se passe pour un corps tombant vers le centre de la terre.

En admettant ce postulat nous devons donc nous attendre à voir les deux atomes s'unir étroitement et dans un état de rapprochement excessif, intime, dès qu'ils auront franchi cette barrière qui sépare les zones d'action de la cohésion de celles de l'affinité.

Reprenons ces deux atomes munis de dynamomètres et observons le phénomène chimique comme nous avons fait pour la cohésion.

Toute la première partie de la chute des deux atomes donnera des valeurs positives d'attraction; arrivés à la distance limite de la cohésion, les dynamomètres indiqueront zéro. Nous continuons à rapprocher les atomes l'un vers l'autre, les dynamomètres exerceront une poussée et absorberont du travail mécanique. Arrivés à une certaine profondeur, la poussée diminuera et atteindra bientôt zéro.

A partir de cette position, l'affinité commence et les deux dynamomètres indiquent de nouveau une attraction tendant à rapprocher les atomes jusque vers une nouvelle limite inconnue, la distance de séparation à la fin de l'action de l'affinité étant beaucoup plus petite qu'à la fin de l'action de la cohésion.

Il convient de faire un diagramme représentant schématiquement les différentes phases de la chute complète de deux atomes hétérogènes l'un sur l'autre. Ce diagramme fera mieux comprendre l'hypothèse que nous adoptons pour l'interprétation des phénomènes physiques et chimiques et sur les quantités d'energie degagées ou absorbées suivant la position respective des masses attirantes.

Dans la Fig. 1, nous plaçons à l'origine des axes OX et OY, l'atome mobile O, tombant sur l'atome, supposé fixe M. Les ordonnées +1 +2 ou − 1 − 2 représentent les lectures faites sur le dynamomètre qui retient l'atome O dans sa chute sur M; ce sont les valeurs numériques résultantes des attractions simultanées de la matière pour la matière et de la matière pour l'éther suivant les distances.

Voici par ordre les différentes phases:

1re phase: Gravitation. L'atome O part de O′ supposé à l'infinie distance de M. L'attraction O′P′ infiniment petite au début, grandit jusqu'à la valeur OP, valeur initiale de la phase inscrite sur le diagramme de la Fig. 1.

Pendant que l'atome O chemine de O jusqu'en A, le dynamomètre inscrit des attractions tracées par la courbe PQR.

C'est la courbe newtonienne pure complétée de tous ses termes.

2me phase: Cohésion. Au point A nous voyons que la courbe inscrite sur les dynamomètres s'écarte du segment RS continuation de

la courbe newtonienne. L'action de l'éther se fait sentir et l'attraction effective diminue rapidement pour devenir nulle lorsque l'atome O est arrivé en B.

La surface du diagramme O′P′PQRS′BO′ représente la somme des travaux positifs fournis par la gravitation et la cohésion depuis les espaces sidéraux, jusqu'au zéro des températures. C'est l'expression totale du potentiel physique des deux atomes O et M. Ce potentiel ment au-dessous de l'axe des X, l'affinité débute par une absorption d'énergie extérieure.

La 2ᵉ période de la 3ᵉ phase commence lorsque l'atome O est en D et se rapproche de M jusqu'en F.

L'attraction devient active. La courbe DUF représente les valeurs successives.

La somme algébrique des deux surfaces BTD et DUM exprime l'énergie totale dégagée ou absorbée par le phénomène chimique.

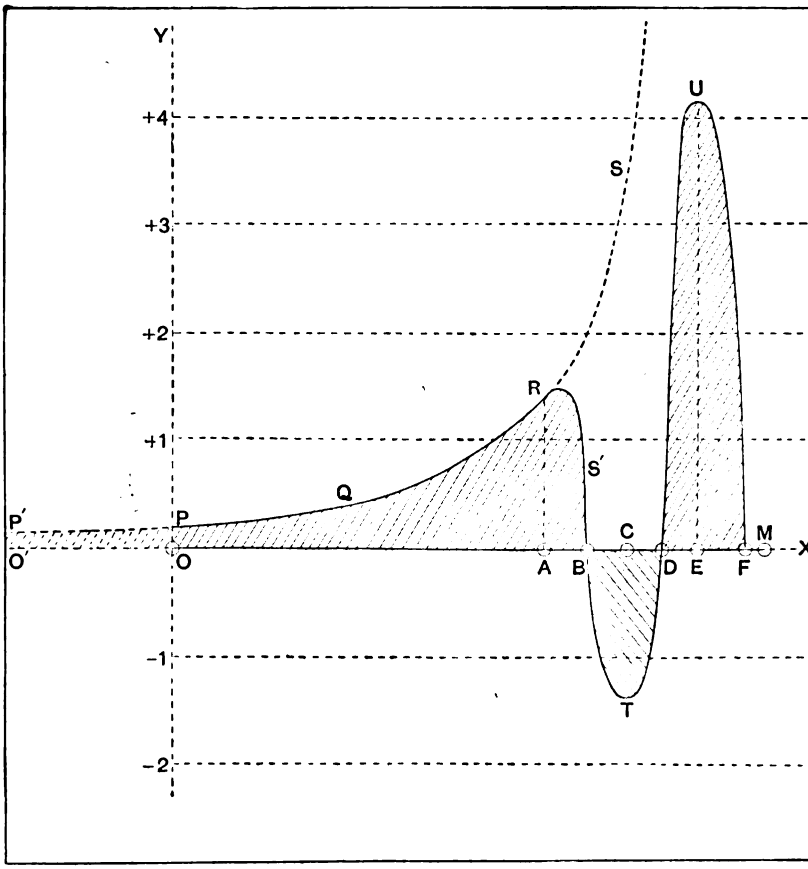

FIG. 1.

est toujours positif sans aucune exception connue.

3ᵐᵉ phase : Affinité. Ainsi que l'indique la courbe QRS′ la valeur numérique de la cohésion est arrivée à être nulle lorsque l'atome O est en B. Nous rapprochons par force les deux masses, la courbe passe sous l'axe des X. La répulsion apparente atteint bientôt son maximum lorsque l'atome O est en C, elle décroît pour être nulle en D. La surface BTD réprésente l'énergie fournie, c'est toujours un travail négatif. La 1ʳᵉ période de la 3ᵐᵉ phase s'inscrira nécessaire-

En connaissant le poids des corps engagés dans une réaction, les chaleurs spécifiques, les variations de températures ou les calories dégagées pendant la réaction, on fixera les vrais paramètres numériques de la chimie mécanique.

A priori nous ne savons rien sur la surface relative de ces différents secteurs positifs et négatifs du diagramme ; ils représentent seulement, d'une façon claire, notre hypothèse fondamentale.

Voici, du reste, la forme analytique générale sous laquelle nous pouvons l'exprimer :

En ramenant tous les phénomènes physiques et chimiques à la chute de deux masses de matière l'une sur l'autre, nous pouvons dire que ces deux masses chemineront le long de la droite qui réunit leurs centres, elles rencontreront toujours et sans aucune exception trois positions d'équilibre ; les deux positions extrêmes sont des équilibres stables, la position médiale est un équilibre instable. La première position d'équilibre s'obtient par la perte de tout le potentiel des forces physiques, gravitation et cohésion des masses, la perte du potentiel chimique fait passer les deux masses par les deux autres positions d'équilibre. Cette loi serait dans notre hypothèse absolument générale.

Avant d'aller plus loin, tirons tout de suite les conséquences expérimentales du postulat que nous venons d'exposer :

En plaçant du soufre et de l'oxygène au zéro absolu dans le voisinage immédiat, nous n'avons pas de réaction. C'est naturel, puisque arrivé aux limites de la cohésion, aucune force suffisante ne rapproche les atomes les uns des autres pour les faire entrer dans leur sphère d'affinité. Nous rappellerons ici que les efforts de compressions extérieures provoqués par les engins les plus puissants connus, produisent des effets presque négligeables rapportés aux dimensions des atomes. C'est ainsi que les efforts de dilatation des liquides font éclater n'importe quel cylindre dans lesquels ils sont enfermés.

Si au contraire on chauffe les deux corps à leur point de contact, on augmente l'amplitude des vibrations.

On sait qu'une partie de cette amplitude s'accomplit dans l'épaisseur de la sphère d'éther que c'est à cette pénétration qu'est due la répulsion apparente de l'atome. Or si l'échauffement est suffisant pour entraîner les deux atomes assez près pour qu'ils passent par le point critique où l'affinité intervient et où elle précipite plus avant les deux atomes l'un sur l'autre, alors, mais alors seulement, la réaction chimique commence.

En réalité la cohésion a passé par degrés insensibles à l'affinité, augmentant toujours sa valeur numérique réelle d'attraction, mais masquée durant un certain chemin par l'action réflexe de l'éther, prépondérante au début de l'action des forces chimiques.

Ce que nous venons de dire pour le soufre et l'oxygène peut se répéter pour tous les corps, même les plus complexes et l'on peut formuler les lois générales suivantes comme conséquences directes et logiques de notre hypothèse.

1° Tous corps hétérogènes quelconques en contact au zéro absolu ou à de très basses températures sous n'importe quelle pression, ne réagissent pas l'un sur l'autre, quelle que soit la puissance de leur affinité.

2° Deux corps hétérogènes très fortement refroidis et ne réagissant pas à ces températures, exigeront toujours une élévation de température définie pour se combiner chimiquement.

3° Plusieurs corps hétérogènes fortement refroidis et lentement chauffés se combineront d'une seule manière, si on les laisse en contact pendant le réchauffement, en admettant que l'on reste maître absolu de la température pendant la réaction.

4° La série des réactions s'effectuera suivant la ligne de plus grande pente chimique des éléments, c'est-à-dire que les premières correspondront à celles dont l'aire BTD, ou la période endothermique, est au minimum. Cet ordre ne sera souvent pas parallèle à la puissance effective totale des énergies dégagées pendant la combinaison finale.

5° Chaque atome qui pénétrera dans la région d'attraction chimique d'un autre atome modifiera immédiatement les propriétés fondamentales de cet atome ; donc en étudiant les phénomènes chimiques, on trouvera que les corps se combinent suivant les poids des atomes ; ces poids représenteront la valeur chimique de chaque corps ; ce sont les équivalents ou les poids atomiques.

Ces phénomènes chimiques sont donc fondamentalement différents des phénomènes physiques qui se passent en toutes proportions des éléments.

Nous ne connaissons actuellement pas la loi newtonnienne de l'attraction pour les faibles distances, encore moins celle de l'affinité et pas davantage celle de l'action de la matière sur l'éther. Nous devons donc uniquement, dans notre hypothèse, voir si une loi newtonienne complète, jointe à une fonction continue exprimant l'attraction réciproque de la matière pour l'éther, peu rendre compte de l'ensemble des phénomènes mécaniques tels que nous venons de les décrire.

Nous avons parlé de fonction continue comme plus d'accord avec la simplicité de l'hypothése.

L'analyse mathématique montre qu'une infinité de fonctions continues satisfont à ces conditions. Nous ne développerons pas ici ce chapitre de mathématique pure car la valeur numérique des fonctions indiquées est absolument inconnue, les constantes ne peuvent se déterminer que par un grand nombre d'expériences faites spécialement dans ce but et lorsque

la science aura fait de grands progrès dans l'art opératoire.

Devant cette possibilité d'exprimer par des fonctions continues simples les lois générales de l'attraction, nous pouvons, sans sortir de la méthode scientifique, pousser plus avant les conséquences à tirer de ces hypothèses sur la constitution des corps. Nous nous rappelons toutefois qu'un contrôle rigoureux expérimental est absolument nécessaire et que ce n'est que par un accord de plus en plus parfait entre les conséquences synthétique, que l'on peut dégager des dites hypothèses et les observations directes, que la probabilité de ces suppositions s'affirmera peu à peu.

Nous devons surtout considérer ces données comme des postulats et nous en servir à ce titre. Ce sont des principes directeurs dans l'organisation des recherches scientifiques.

III.

Utilisons donc les considérations qui précèdent dans l'analyse des phénomènes de combinaison et de dissociation en tenant compte des quantités de chaleur fournies ; nous voulons faire dans ce chapitre une étude synthétique de mécanique chimique, il faut donc voir, par le détail, le cycle complet des phénomènes et jeter tous les ponts possibles entre les facteurs divers que nous rencontrerons sur la route.

Rappelons d'abord la loi commune de la chute de tous les corps chimiques quelconques, appelée loi de Newton.

Grâce à cette loi, nous sommes en droit de représenter mécaniquement toutes les masses des corps en fonction de leurs poids mesurés par la balance.

Cette loi nous montrant que l'inertie et l'attraction sont toujours proportionnelles, quels que soient les corps chimiques étudiés, il est très probable, presque certain, que l'élément infiniment petit qui constitue le vrai noyau original de chaque corps est identique dans tous les corps, puisqu'il présente partout les mêmes propriétés fondamentales de la matière : inertie et attraction. Cette conséquence donnerait raison au vieux Pythagore qui affirmait, il y a longtemps, que tout en physique et en chimie, se calculerait un jour " par le nombre."

Il résulte de ces considérations que la force vive dégagée par toute réaction se mesurera exactement par le produit de trois facteurs : le poids des corps engagés, l'élévation de la température provoquée par la réaction, la chaleur spécifique des constituants.

En examinant le diagramme tracé par le dynamomètre pendant l'entrée en vigueur de l'affinité, nous avons vu que cette partie de la courbe présente toujours et nécessairement deux périodes : la première est négative, la seconde est positive.

Dans la première période, il faut fournir un travail extérieur, exciter la réaction.

Dans la seconde période, la réaction continue d'elle-même et fournit, produit de la chaleur.

La première période sera " endothermique," la seconde " exothermique," pour employer les mots créés par l'illustre chimiste M. Berthelot dans sa " Mécanique chimique."

Une réaction chimique de deux ou plusieurs corps est donc toujours une différence entre deux travaux mécaniques de sens contraire.

Suivant que la première période l'emporte sur la deuxième ou inversement, nous devons nous attendre à trouver deux grandes classes de combinaisons chimiques :

Dans la première, en passant des éléments constitutifs au produit final, on obtient comme somme une source de chaleur, une élévation de température, ces réactions une fois commencées sur un point quelconque du mélange intime des constituants, se propagent d'elles-mêmes dans toute la masse.

La vitesse de propagation de la réaction dépend du degré d'intimité du mélange, de la disposition topographique des atomes dans l'espace voisin du départ de la combustion. L'explosion de l'hydrogène uni à l'oxygène est un type de ces réactions exothermiques ; la combustion du bois, du charbon, etc., caractérisent aussi cette classe de phénomènes par la possibilité où l'on est de mesurer très exactement la vitesse de propagation de la réaction.

Dans la deuxième catégorie se rangent toutes les réactions endothermiques, celles qui absorberont de la chaleur pour passer des constituants au produit final.

On sait déjà, par principe, que ces réactions ne se passeront jamais d'elles-mêmes, il faudra non-seulement les exciter mais encore les alimenter. Une source d'énergie extérieure devra à chaque instant remplacer la perte subie pendant la réaction.

Nous pouvons assez exactement comparer une réaction endothermique à la charge d'une arbalète : on appuie sur la corde en fournissant du travail, puis l'arrêt intervient qui fixe la corde à fin de course. En pressant la détente on obtient le travail balistique.

On peut donc affirmer que tous les produits obtenus par cette seconde catégorie de réactions contiennent plus d'énergie potentielle que les constituants, ils représentent la grande classe

des accumulateurs dans le sens le plus général du mot.

Ces produits chimiques conduisent immédiatement à la notion des explosifs.

La formation de l'eau oxygénée par l'action de l'acide chlorhydrique sur le bioxyde de baryum indique bien l'allure des réactions endothermiques. Il se forme du chlorure de baryum dégageant +11 calories, tandis que l'eau oxygénée absorbe −11·6 calories. La chimie abonde en cas analogues.

Il va sans dire que les décompositions de tous les produits obtenus provoqueront des phénomènes inverses mécaniquement parlant à ceux qui se sont manifestés pendant la combinaison.

Il est par conséquent possible de prévoir par ces hypothèses :

1° Toutes les lois de la dissociation.

2° L'influence des températures et des pressions sur les décompositions chimiques.

3° Les conditions de la stabilité.

4° L'ordre dans lequel les réactions de différents corps s'effectueront en fonction des températures.

5° Réciproquement l'ordre des dissociations, etc.

6° Les doubles décompositions, conséquences des lois de Berthollet, se déduisent également de ces considérations et l'on peut calculer à l'avance les chaleurs perdues ou gagnées suivant la température à laquelle se passe la réaction.

En somme d'une façon générale l'accord entre les conséquences que l'on peut déduire des hypothèses et les faits consacrés par l'expérience est suffisant pour que nous ayons entrepris une série d'observations dont le cadre a été dicté par ces principes mécaniques.

IV.

La première série d'expériences a consisté à démontrer qu'aux très basses températures la réaction de tous les corps hétérogènes juxtaposés est nulle, même si l'on obtient un contact intime en pulvérisant les corps ou en les serrant fortement l'un contre l'autre.

Ces expériences ont donc pour objet essentiel de prouver que, dans toutes les manifestations de l'affinité, la première période est endothermique.

Nous avons choisi pour commencer naturellement les corps dont l'affinité réciproque est la plus énergique.

Dans notre laboratoire de Berlin nous disposons d'appareils à marche continue qui nous permettent de produire et de conserver indéfiniment de très basses températures.

De grands cylindres à double enveloppe servent d'enceintes froides. Nous en avons huit de dimensions variables, les uns horizontaux, d'autres verticaux.

Les uns sont utilisés pour la condensation des gaz et des vapeurs sous des pressions variant de 200 atmosphères jusqu'au vide presque absolu.

Dans la double enveloppe, nous introduisons les divers liquides volatils qui servent à obtenir les basses températures ; un groupe de cinq compresseurs agissant " en compound " aspirent et compriment les vapeurs de ces liquides et refroidissent les cylindres à n'importe quelle température que l'on désire, comprise entre la température ambiante et −213° au-dessous de zéro, température extrême obtenue par le *vide* sur " l'air atmosphérique liquide."

Il est impossible d'obtenir d'une seule fois des abaissements de température aussi considérables.

Nous refroidissons les corps au moyen de trois cycles successifs fonctionnant chacun entre des limites de température pas trop écartées.

Le premier cycle fonctionne au moyen d'un mélange d'acide sulfureux anhydre et d'acide carbonique. Ce liquide, introduit dans la double enveloppe des cylindres, permet de les refroidir à −100° facilement. Les vapeurs sont reliquéfiées dans des serpentins noyés dans de l'eau ordinaire courante, et le liquide ainsi reconstitué sert à alimenter l'opération frigorifique, car il suffit d'entr'ouvrir légèrement un robinet reliant le bas du condenseur avec la double enveloppe pour que le liquide volatil se précipite de lui-même dans cette enceinte où la pression est infiniment plus faible. Il y prend instantanément la température correspondant à la pression des vapeurs dans cet appareil.

Des manomètres à mercure facilitent la connaissance exacte, et pour chaque instant, des phénomènes intérieurs et indiquent la température par la pression.

Les différents cylindres verticaux que nous avons spécialement fait construire pour toutes les expériences du premier cycle sont au nombre de quatre.

Le plus grand a 350 millimètres de diamètre intérieur et 1·350 m. de hauteur.

Le plus petit a 160 millimètres de diamètre et 200 millimètres de hauteur.

Les autres sont intermédiaires.

Le deuxième cycle fonctionne au moyen du protoxyde d'azote ou de l'éthylène.

Pour obtenir ces gaz à l'état liquide on se sert du premier cycle et des basses températures qu'il procure. On liquéfie dans l'un des cylindres horizontaux refroidi à −80° le protoxyde d'azote, par exemple, sous une pression de 6 à 12

atmosphères ; nos appareils peuvent en fournir 25 à 30 kilogrammes à l'heure.

Ce protoxyde d'azote liquide, et déjà très froid, passe dans la double enveloppe d'un autre cylindre vertical. Lorsqu'on fait le vide dans cette double enveloppe, il s'y évapore en cristallisant et en abaissant la température jusqu'à $-135°$ et $-150°$.

Les vapeurs aspirées par un groupe de deux compresseurs sont incessamment reliquéfiées pour retourner dans le cylindre réfrigérant sous forme liquide.

Ces deux cycles sont entièrement fermés, continus et fonctionnent aussi longtemps qu'on le veut à toutes les températures comprises entre les limites indiquées. En reglant la vitesse relative des compresseurs, et en modifiant, suivant les besoins, les ouvertures des vannes placées sur les canalisations des vapeurs, il est aisé de régler la marche des appareils d'une manière mathématique.

Les deux cycles fonctionnent bien plus facilement qu'une machine à haute température au point de vue de la régularité et de la souplesse des manœuvres.

Chaque compresseur possédant son moteur à vapeur special, le régime de la marches s'établit progressivement, les ouvriers mécaniciens attachés au laboratoire étant tout à fait formés à ces diverses opérations.

Le troisième cycle est obtenu par la liquéfaction de l'air atmosphérique dans un tube horizontal refroidi au-dessous de $-120°$ par le jeu du deuxième cycle.

Une pompe à glycérine comprime 700 litres d'air à la pression de 200 atmosphères dans le tube central du réfrigérant du deuxième cycle.

La pression tombe à 90 atmosphères et l'air se liquéfie. En laissant sortir cet air liquéfié dans une petite enceinte déjà refroidie à l'avance on atteint $-210°$ à $-213°$ à la limite extrême du vide établi dans l'enceinte.

Ce dernier cycle est encore intermittent et pas fermé comme les deux premiers.

Il donne chaque heure environ 1 k. 500 d'air liquide, la compression de l'air jusqu'à 90 au 200 atmosphères exigeant toujours un temps assez long.

Nous venons de décrire d'une façon très sommaire l'appareil avec lequel nous produisons et maintenons les basses températures, nous rentrons dans notre sujet.

Dans le réfrigérant du deuxième cycle nous introduisons dans des éprouvettes de verre les substances chimiques suivantes, absolument pures :

1° Acide sulfurique 95 p. 100 de concentration.

2° Soude caustique pulvérisée très fine.

3° Potasse caustique id. id.

4° Ammoniaque en solution aqueuse 23 p. 100 en poids d'ammoniaque.

5° Acide nitrique fumant.

6° Sel marin pulvérisé très fin.

Après avoir laissé plusieurs heures tous ces produits se refroidir jusqu'à $-125°$ environ, nous avons mis en présence, dans un cristallisoir refroidi, les corps suivants dans l'ordre ci-après.

A.—*L'acide sulfurique et la soude caustique.*

L'acide sulfurique a été extrait de l'éprouvette en verre en cassant celle-ci avec une pince en acier ; le bloc d'acide sulfurique solide est tombé dans la poussière de soude et au moyen d'une baguette de verre on a fortement agité le mélange et pressé les corps mécaniquement de telle sorte que les petits morceaux de soude avaient pénétré dans le bâton d'acide solide.

Nous n'observons aucune réaction quelconque, les corps restent absolument inertes.

J'avais disposé une forte bobine Ruhmkorff pour obtenir des étincelles de 30 à 35 millim. de longueur. Deux fils isolés et tenus dans un tube de verre, conduisaient le courant et l'étincelle à l'extrémité des deux fils découverts où elle jaillissait sur une longueur variable à volonté.

Nous avons constaté que l'acide sulfurique solide conduisait très bien l'étincelle que nous obtenions tout le long du bâton, un des fils étant fixe à une des extrémités.

Pendant plus d'un quart d'heure nous avons fait passer l'étincelle et nous avons vu que la réaction ne s'opérait qu'au point exact où l'étincelle jaillissait sans se propager à toute la masse.

Nous avons alors sorti l'éprouvette du froid et l'avons laissée exposée à l'air ambiant.

La température est assez vite remontée, mais avant que l'acide sulfurique fut fondu, la réaction s'est subitement déclarée dans toute la masse et l'éprouvette en verre s'est cassée par suite de la haute élévation de température qui a accompagné cette réaction en masse.

Nous pouvons approximativement fixer à $-80°$ ou $-85°$ la température où la réaction en masse a pris naissance.

Le fait principal est établi : aux basses températures, pas de réaction entre ces deux corps sans le secours d'une énergie étrangère qui, dans ce cas, est l'influence de décharges électriques.

B.—*Acide sulfurique et potasse caustique.*

Nous pouvons répéter ici exactement ce que nous venons de dire pour la réaction *A* avec

cette seule différence que la réaction en masse a commencé à une température plus basse que pour la soude caustique—peut-être $-80°$ ou $-90°$. Les déterminations exactes de ces valeurs de la température sont encore à faire car elles offrent des difficultés toutes spéciales.

C.—*Acide sulfurique et ammoniaque.*

Ici encore les mêmes allures générales des phénomènes, action nulle au départ, la réaction se produit sans se développer aux basses températures au-dessous de $-65°$, puis subitement la réaction en masse élève la température du tout au-dessus de $+100°$.

D.—*Acide sulfurique et sel marin.*

Même allure que *C*; sauf la fin qui a été moins violente. La réaction n'a commencé à marcher d'elle-même qu'au-dessus de $-25°$.

E.—*Acide nitrique fumant* 89 *p.* 100 *et soude caustique.*

Au premier contact pas de réaction pendant peut-être 30 à 40 seconds, puis commencement lent avec élévation de température des points en travail, enfin violente et brusque transformation de la masse avec dégagement de vapeurs rutilantes.

Ici l'opération a commencé d'elle-même sans l'influence de l'étincelle électrique sous le seul effet de l'élévation de la température hors de l'appareil, pour éviter l'action des vapeurs sur les instruments.

La réaction s'est effectuée en trois minutes environ à partir de la sortie de l'appareil froid.

Le dépôt de vapeur d'eau aux surfaces de contact de la soude et de l'acide a probablement facilité et excité la réaction en masse.

F.—*Acide nitrique fumant* 89 *p.* 100 *et potasse caustique.*

Exactement la même allure que pour *E* peut-être un peu plus rapide, le premier contact avant la réaction en masse a cependant duré plusieurs secondes.

G.—*Acide nitrique fumant et sel marin.*

Réaction nulle jusqu'à $-74°$. Depuis ce moment et avec le secours de l'étincelle électrique, la réaction commence. Elle ne devient une réaction en masse que vers $-20°$.

De cet ensemble de faits il ressort avec une grande clarté :

1° Que les corps chimiques ne se combinent pas directement aux basses températures, sans le secours d'énergie étrangère.

2° Que la réaction en masse succède toujours à une période pendant laquelle la réaction a lieu seulement par places électives, dans lesquelles on fournit l'énergie électrique ou calorifique.

3° Que la température basse est parfaitement réglable et maintenable, soit lorsque les corps n'agissent pas encore, soit lorsque la réaction ne s'opère que sur les places électives.

4° Que la température se relève brusquement sans qu'on puisse en être maître, au-dessus de la température limite à laquelle commence la réaction en masse.

5° Les températures pour lesquelles on peut obtenir et conserver la réaction limitée, sont d'autant plus basses que les affinités des corps mis en présence sont plus grandes et le contact des corps plus intime.

Il résulte de cette partie de notre étude que l'expérience a pleinement confirmé les previsions dégagées logiquement de nos hypothèses. Toute réaction chimique commence nécessairement par une période endothermique. Cette période est plus ou moins longue suivant les réactifs ; on peut la régler par le seul jeu de la température.

En présence des affinités puissantes des corps jouant le rôle principal en chimie, l'emploi des basses temperatures s'impose comme un facteur ayant une valeur intrinsèque, et qu'il est impossible de remplacer par aucun autre agent physique.

De même que pour la liquéfaction des vapeurs, la température joue un rôle caractéristique, équivalent à celui d'une variable indépendante dans une équation, de même dans l'affinité amenant la réaction chimique, nous retrouvons les mêmes lois, les mêmes fonctions spéciales de la température que pour les phénomènes de la cohésion, origine et cause des liquéfactions.

Ces considérations mécaniques réunissent donc dans le même chapitre la gravitation, la cohésion et l'affinité, toutes trois se manifestant comme le développement normal de deux fonctions continues représentant l'attraction de la matière pour la matière et pour l'éther.

Avant de passer à des opérations de synthèse chimique proprement dite, nous avons voulu observer quelques phénomènes de basse température pour répondre à certaines questions qui se posent de suite dés l'entrée en matière dans ce domaine.

Et d'abord un premier point : si l'on refroidit suffisamment les corps pour les rendre solides ou tout au moins pâteux, ce changement d'état n'est-il pas la cause efficiente de l'absence de réaction. En somme ne serait-il pas possible d'obtenir une réaction même à basse température si les corps en présence gardaient la forme liquide ou gazeuse ? Secondement : si l'on s'adresse à des réactions très sensibles comme l'action des acides sur la teinture de tournesol, l'action des

alcalis sur la phénolphtaléine, réactions qui paraissent développer au simple contact avec une période endothermique très faible, pourra-t-on les annuler par les grands froids ?

Dans cette direction nous avons fait les préparations suivantes :

1. *Acide sulfurique et carbonate de chaux* (*marbre pilé pur*).

Nous avons choisi la solution d'acide sulfurique qui reste liquide à la plus basse température, sa formule est $H_2SO_4 + 7_2HO$ refroidie à $-70°$ et restant liquide à cette température. Le marbre en poudre était refroidi, de son côté, à $-89°$. On jette le marbre dans l'acide sulfurique.

Aucune réaction pendant plus d'une demi-heure.

A $-52°$ en laissant lentement remonter la température on aperçoit les premières traces de réaction.

Le dégagement augmente progressivement jusqu'à $-15°$.

De $-15°$ à $-7°$ la réaction est de plus en plus énergique et devient turbulente avec mousse abondante.

2. *Acide sulfurique et carbonate de soude.*

Les cristaux de carbonate de soude refroidis à $-85°$ sont jetés dans l'acide sulfurique $SO_4H_2 + 7H_2O$ liquide à $-83°$.

Nous remuons fortement avec une baguette de verre refroidie et nous constatons que la réaction est nulle.

Nous laissons remonter la température à $-56°$ où la réaction apparait. De petites bulles commencent à se dégager.

A $-30°$ le dégagement est bien nettement établi et à $-23°$ la réaction est turbulente et générale.

3. *Acide sulfurique et chlorure de baryum.*

L'acide sulfurique est refroidi à $-115°$ restant liquide. Le chlorure de baryum est dissous dans l'alcool peu étendu et refroidi à $-135°$. On jette dans l'acide sulfurique la solution alcoolique de chlorure et des cristaux de chlorure de baryum en agitant le mélange.

L'acide sulfurique laisse surnager les cristaux mais ne se trouble nullement, on ne peut distinguer aucun voile dans la liqueur.

A $-70°$ la réaction commence et à partir de ce point elle s'accentue de plus en plus.

4. *Acide chlorhydrique et nitrate d'argent.*

Nous prenons de l'acide chlorhydrique ayant 33 p. 100 et ne gelant pas à $-130°$.

Le nitrate d'argent est dissous dans l'alcool et reste liquide à $-125°$. On mélange les deux liquides, aucune réaction. Vers $-109°$ la liqueur commence à se troubler. Audessus la réaction devient générale.

5. Réactions très sensibles des acides sur la teinture de tournesol.

Acide sulfurique et solution dans l'alcool de la teinture de tournesol bleue.

Nous refroidissons l'acide à $-140°$ ainsi que la solution alcoolique qui est pâteuse.

En les mélangeant ensemble intimement au moyen d'une baguette de verre refroidie, la solution reste bleue indéfiniment.

En laissant remonter la température, la couleur passe au violet vert $-110°$ sans atteindre le rouge.

Ce n'est qu'à $-105°$ que le rouge vif apparaît.

En faisant la même expérience, mais en plongeant dans la liqueur à $-120°$ degrés une baguette de verre ayant la température ambiante, nous avons vu se produire un cylindre rouge vif au sein de la liqueur au contact des parois de la baguette. La réaction s'est produite sur une profondeur de 2 à 3 millimètres autour du cylindre de verre.

Acide chlorhydrique et solution alcoolique de tournesol.

L'acide reste liquide à $-140°$. Nous y jetons la solution pâteuse de tournesol et nous mélangeons.

La liqueur reste parfaitement bleue sans changement.

A $-115°$ la coloration violette apparaît et se change en rouge vif à $-110°$.

6. *Réaction sensible des alcalis sur la phénolphtaléine.*

On sait que la phénolphtaléine donne avec les plus petites traces d'alcali une belle couleur rouge foncé ; cette réaction est souvent utilisée pour les titrages de potasse et de soude.

Nous faisons séparément deux solutions dans l'alcool absolu de potasse caustique et de phénolphtaléine.

Nous vérifions qu'aux températures ambiantes la réaction rouge apparaît instantanément puis nous refroidissons les deux éprouvettes à $-145°$. Les deux solutions sont visqueuses à cette basse température.

Nous les mélangeons intimement une fois refroidies.

Aucune réaction, pas trace de coloration rouge.

A $-100°$ la teinte rosée commence à se manifester, à $-90°$ la coloration est complète.

7.—*Sodium et potassium sur l'alcool hydraté.*

Nous refroidissons du sodium métallique à $-80°$ ainsi qu'une éprouvette pleine d'alcool à 84 p. 100 en poids et 16 p. 100 d'eau. En jetant le sodium dans l'alcool nous constatons que le sodium reste brillant sans aucune attaque.

La réaction commence à $-48°$ et se développe

alors assez vite à cause de l'élévation spontanée de la température.

Pour le potassium nous opérons de même et nous constatons que de $-80°$ à $-70°$ il n'y a aucune réaction.

La réaction débute assez brusquement à $-68°$ environ et part avec énergie plus violemment qu'avec le sodium.

8.—*Acide nitrique fumant et alcool.*

On sait que cette réaction est très énergique aux températures ordinaires. En mélangeant ces deux liquides refroidis séparément à $-88°$ il n'y a pas de réaction. Elle ne commence qu'à $-70°$ et vers $-60°$ elle devient vive et brusque.

RÉSUMÉ.—Nous pouvons résumer l'ensemble des recherches faites dans cette direction ainsi que suit :

1° Entre les températures comprises entre $-155°$ et $-125°$ nous n'avons pu constater aucune réaction chimique, quelle que soit la nature des corps mis en présence.

2° Les réactions sensibles, comme l'effet des acides sur la teinture de tournesol, etc., se produisent à plus basses températures que d'autres réactions très énergiques, sodium métallique sur l'acide sulfurique par exemple.

3° Dans toutes les réactions chimiques, nous pouvons trouver deux phases suivant la température à laquelle on opère :

A. La réaction lente qui se produit au-dessous d'une température limite, spéciale pour les corps mis en présence ; cette réaction se manifestant sous l'influence de l'étincelle électrique ou spontanément suivant l'écart qui existe entre la température actuelle et cette température limite.

B. La réaction en masse, dans laquelle l'élévation de température produite par les parties qui réagissent, communique aux parties voisines assez de chaleur pour les faire aussi réagir ; c'est une sorte d'embrasement général qui n'est modéré que par les conditions physiques imposées au rapprochement des particules qui se combinent.

Dans la plupart des cas, pour obtenir et conserver la réaction lente, il faut enlever par rayonnement la chaleur développée par la combinaison, sans quoi la température passe très vite à la limite de la réaction en masse.

4° L'étincelle électrique semble être le meilleur excitant pour provoquer la réaction lente.

5° Il est donc expérimentalement constaté que toute réaction chimique commence toujours par une période d'énergie négative, c'est-à-dire dans laquelle il faut fournir du travail extérieur aux composants pour permettre leur combinaison.

Le travail chimique appelé par M. Berthelot travail préliminaire ou préparatoire, est donc un fait général dans la nature.

V.

Après les confirmations expérimentales qui précèdent et qui n'ont d'autre but que de donner quelque poids aux hypothèses émises et adoptées comme postulat, nous allons décrire d'autres expériences guidées directement par ces vues théoriques et destinées à "conduire les premiers essais de synthèse chimique par l'emploi rationnel des basses températures."

Les premières observations ont été faites pour obtenir les composés nitrés du toluène, de la naphtaline et du phénol par des réactions à basses températures.

Dans les réactions sur le toluène et la naphtaline, nous avons pris des températures suffisamment élevées pour que la réaction se fasse spontanément sans le secours d'énergie étrangère. Nous avons introduit par très petites quantités dans un mélange de SO_2H_2 et NO_3H le toluène ($C_6H_5-CH_3$).

Dans la troisième série d'expériences sur le phénol, nous sommes descendus au-dessous de la température limite pour le départ de la réaction en masse et nous avons mélangé dès le début les corps composants dans les proportions définies à l'avance, après les avoir refroidis.

L'étincelle électrique a été employée pour provoquer la réaction limitée jusqu'à épuisement des produits.

Voici les résultats obtenus, soit aux températures ordinaires d'environ $+30°$ à $+35°$ soit aux basses températures entre $-50°$ et $-55°$.

On sait que le toluène forme deux dérivés isomères lorsqu'on le soumet à l'action de l'acide nitrique, partageant du reste cette propriété avec tous les produits contenant le groupe CH_3 en chaîne secondaire.

Ces deux dérivés sont :

1° L'ortho-nitrotoluène liquide aux températures ordinaires et bouillant à $+222°$.

2° Le para-nitrotoluène solide jusqu'à $+54°$ et bouillant à la température de $+237°$.

Ces deux produits sont très difficiles à séparer par rectification à cause du voisinage de leur point d'ébullition.

Un de ces deux groupes doit sûrement correspondre au travail maximum de l'énergie de constitution, un de ces dérivés doit être le résultat du "travail par la plus grande pente chimique."

C'est ce dérivé certainement que nous devons accroître en faisant la réaction aux basses températures.

Plus nous opérons à basse température, plus ce produit doit l'emporter en quantité relative sur l'autre.

La loi chimique déterminant la position des groupes entrant dans le noyau, suivant la composition moléculaire déjà existante, est formelle ; nous ne pouvions guère nous attendre à voir intervenir d'autres groupements atomiques mais bien une différence dans le poids des produits obtenus. Sur 100 parties en poids traitées, nous trouvons aux températures de $+30°$ $+35°$.

Orthonitrotoluène . .	60 p. 100
Paranitrotoluène . .	40 p. 100
Total . .	100 parties.

Pour opérer aux basses températures, c'est goutte à goutte que nous avons laissé tomber la solution de toluène refroidie à $-50°$ $-55°$ dans le mélange froid de SO_4H_2 avec NO_3H.

Nous avons énergiquement remué pour répandre le liquide introduit dans la masse et après la réaction finie laquelle n'a pas pu élever la température d'une façon très appréciable, vu la marche continue des appareils frigorifiques, nous avons procédé à la séparation fractionnée dans le vide.

Nous avons alors obtenu :—

Orthonitrotoluène . .	86 p. 100
Paranitrotoluène . .	15 p. 100

Le rapport en poids des deux dérivés s'est donc totalement modifié car nous avons :

A $+35°$ 1·5 d'orthonitrotoluène par rapport au paranitrotoluène ; à $-50°$ nous trouvons 5·5 pour la proportion relative des mêmes produits.

La seconde série de synthèses a porté sur les composées de la nitronaphtaline.

Nous avons pris les méthodes qui, aux températures ordinaires, ne donnent que ce produit pur, avec seulement des traces des autres composés parallèles ; l'influence des basses températures dégagerait le sens des plus grandes affinités.

Nos prévisions n'ont point été déçues et les réactions à basses températures ont fait apparaître des combinaisons toutes nouvelles dans un semblable milieu.

L'opération a consisté à refroidir à $-55°$ un mélange d'acide sulfurique concentré et d'acide nitrique fumant. Puis on laisse tomber dans le liquide pâteux de la poudre fine de naphtaline refroidie. En agitant fortement, la réaction s'opère et l'on empêche l'élévation de température par le fonctionnement des appareils frigorifiques qui maintiennent les enveloppes du cylindre, servant de puits à réaction, bien au-dessous de $-50°$, vers $-90°$ environ. Le rayonnement suffit pour enlever toute la chaleur produite.

Voici les résultats curieux et nouveaux obtenus :

Nous n'avons que :

20 p. 100 d'x-nitronaphtaline au lieu de 100 p. 100 obtenus à haute température. Ce corps fond à $+61°$.

28 p. 100 de x-dinitronaphtaline et

40 p. 100 de y-dinitronaphtaline dont le point de fusion est à $+144°$.

12 p. 100 de naphtaline non transformée.

Jusqu'à présent on n'avait obtenu la y-dinitronapthaline que par l'emploi transitoire de la dinitro-x-naphtylamine. Il est intéressant de l'avoir obtenue par voie directe et en si grande proportion.

Cette réaction donne donc à ce produit une place spéciale au point de vue des affinités mises en jeu.

La troisième série d'expériences a été faite par l'emploi de l'énergie auxiliaire de l'étincelle électrique.

Nous avons opéré sur le phénol par l'acide nitrique.

Afin de bien constater l'effet des basses températures nous avons commencé par chercher expérimentalement le point où la réaction en masse des deux produits a encore lieu.

Faisant d'abord la réaction à 0°, nous avons mêlé ensemble progressivement 160 grammes d'acide nitrique de 1·34 comme densité, étendu de son double poids d'eau, avec 80 grammes de phénol fondu, le ballon et ses annexes étant toujours maintenus dans la glace pilée. On lave le liquide obtenu, et on distille par l'emploi du vide et des vapeurs d'eau. On sépare ainsi les deux produits : l'orthonitrophénol du paranitrophénol.

En opérant deux fois : la première ainsi qu'il vient d'être dit, la seconde en plongeant le ballon à $-40°$ seulement, nous avons constaté que la réaction à $-40°$ était assez vive pour faire remonter subitement la température à $-20°$ dans le ballon de verre. La réaction en masse se produisait encore à $-40°$.

Les deux essais, dans ces conditions, ont fourni la même quantité de paranitrophénol environ 6 grammes.

Après cet essai nous avons fait le suivant. Nous avons pris 160 grammes d'acide nitrique d'une densité de 1·34 non étendu, refroidi à $-45°$ $-50°$. Nous avons fait une solution de phénol dans l'éther sulfurique refroidie aussi à $-45°$ $-50°$. En mélangeant ces deux solutions

froides il ne se passa pas de réaction immédiatement, mais après quelques instants une véritable explosion chassa le contenu du vase jusqu'au plafond du laboratoire, la réaction en masse venait de se produire. Par contre le temps perdu entre le mélange et l'explosion prouvait que nous étions bien près de la température limite cherchée.

Cette expérience nous amena au dernier essai suivant: Réduisant de moitié les quantités engagées, nous congelâmes 80 grammes d'acide nitrique, densité 1·34, à la température de $-50°$ à $-60°$ et 40 grammes de phénol fondu, répandu progressivement dans la masse sous forme aussi divisée que possible. La température basse était rigoureusement conservée. Aucune réaction ne se manifesta, nous étions au-dessous de la température de réaction en masse. Alors nous servant de l'étincelle électrique, nous avons fait traverser le mélange par le courant en ayant soin de ne jamais exagérer à la même place le passage des étincelles.

La réaction totale a eu lieu progressivement sans aucune élévation de température apparente, vu ces précautions.

Après la distillation et la séparation methodique par rectification des deux produits, nous avons trouvé 15 grammes de paranitrophénol, soit une préparation cinq fois plus forte si on la compare aux poids des composants mis en présence aux températures normales.

Outre ce produit nous avons fait à haute et basse température le métanitrophénol.

En passant par le dinitrobenzène et la métanitraniline sous l'action de l'hydrogène sulfuré dans une solution ammoniacale, puis en diazotant la métanitraniline, les réactions obtenues à basse température ont donné un rendement double comparativement aux résultats des opérations similaires à la température ambiante.

Il résulte de tous ces faits que, par le choix convenable des basses températures, nous avons modifié d'une façon profonde toutes les réactions concernant la nitrification du toluène, de la naphtaline et du phénol.

Nous sommes occupés à compléter ces travaux de chimie synthétique pour en dégager des lois numériques, avec mesure des paramètres, afin de les présenter sous une forme pratique et immédiatement utilisables dans les laboratoires.

Ce que nous venons de dire suffit pour nous permettre d'esquisser la première charpente encore rudimentaire d'une méthode générale de synthèse chimique.

VI.

Les faits que nous venons d'exposer d'une façon très concise corroborent complètement l'espoir que nous avions de voir les phénomènes chimiques transformés et modifiés par l'emploi rationnel des basses températures.

Nous allons tâcher de résumer les conséquences qui découlent, tant des hypothèses émises que des vérifications déjà faites, pour asseoir les premiers jalons d'une méthode opératoire permettant d'obtenir par voie synthétique et certaine tous les corps de la nature.

En prenant tous les corps simples connus et les plaçant en présence aux très basses températures, nous savons qu'ils ne réagissent pas l'un sur l'autre.

Il faudra commencer par faire la table expérimentale des températures auxquelles les réactions commencent, toutes les autres conditions restant du reste les mêmes (mélange, pression, éclairement, etc.).

Il faudra de même étudier au-dessous de cette température tous les effets chimiques dus aux divers excitants connus; étincelle électrique, corps chauds, réactions auxiliaries, etc.

On formera ainsi la 1re table de dynamique chimique: le chemin de plus grande pente des éléments chimiques. On saura par cette table à quelle température exacte il faut porter un corps en présence d'un autre pour n'avoir qu'une seule solution au problème chimique.

On passera ensuite aux composés binaires, réunis à un corps simple et l'on opérera exactement de la même façon que précédemment. Ce sera la 2e table dynamique. La 3e table dynamique donnera l'ordre des réactions des corps binaires en contact avec les corps binaires à toutes les températures, etc.

Lorsque le nombre de ces observations sera considérable, les lois de ces réactions apparaîtront avec la même netteté que celles que l'on connaît aujourd'hui. Ces lois du reste en font partie, seulement d'une façon confuse puisqu'elles procèdent du mélange de toutes les tables dynamiques.

Nous pouvons donc opérer plus tard ainsi que suit:

Nous voulons produire un corps ayant par exemple: A atome d'hydrogène, B d'oxygène, C d'azote, et D de carbone, etc.

Nous connaissons déjà par les tables le noyau le plus ancien, c'est-à-dire celui qui se forme à la température la plus basse, se rapprochant du corps demandé.

Pour ajouter à ce noyau de l'oxygène, du carbone ou de l'azote, nous connaissons les réactions caractéristiques provoquant ces réactions et les températures minima nécessaires pour ne permettre que celles-là.

Nous utiliserons successivement toutes les tables et les lois qui les accompagnent pour grossir la molécule primitive de tous les affluents que nous voulons lui faire recevoir. En empêchant les réactions en masse, en ne produisant que des réactions limitées et précises, la conduite des opérations présentera le caractère de nécessité puisqu'il sera toujours le fidèle écho de la ligne de plus grande pente des composants.

Il est clair qu'une semblable étude embrasse des années de recherches préliminaires. Il faut classer des milliers de phénomènes qui se succèdent degré par degré ; tous les facteurs les plus variés interviennent.

En somme, nous décrivons une méthode synthétique reposant sur la série ascendante des phénomènes dus à l'affinité par ordre de date, si le temps croît en fonction des températures. Le chemin est unique et ne doit nulle part présenter d'ambiguité.

Le rôle des basses températures est double ; d'une part elles paralysent toutes les réactions, sauf celle que l'on veut produire, d'autre part en enlevant au fur et à mesure qu'elles se forment, les quantités de chaleur dues à l'affinité transformée en chaleur, elles empêchent la température de s'élever et de favoriser des réactions perturbatrices que l'on ne pourrait plus maîtriser.

On déduit de ces faits une règle qui doit diriger la construction des appareils à réactions chimiques synthétiques. La puissance frigorifique de ces appareils doit être considérable et leur fonctionnement modifiable à volonté, soit comme température, soit comme effet en calories enlevées.

De plus il faut pouvoir introduire dans l'intérieur des masses refroidies, soit sous forme liquide, soit sous forme de poudre, mais en quantités réglables les corps servant de réactifs, refroidis eux-mêmes au préalable.

Enfin les "excitants" doivent pouvoir opérer dans l'intérieur des "chambres froides" et leur action doit être aussi facilement réglable que la marche des appareils frigorifiques.

Avec une pareille disposition, l'étude synthétique des phénomènes chimiques peut entrer dans une voie parfaitement méthodique, bien que longue et complexe.

Lorsque dans un laboratoire aux températures ordinaires on mélange les divers réactifs ensemble, il est souvent très difficile de prévoir l'issue de la combinaison. Chaque réaction élémentaire apporte avec elle son énergie qui n'est pas éliminée et permet à d'autres réactions plus complexes ne se manifester, celles-là, elles aussi, interviennent pour établir de nouvelles relations dynamiques entre ces substances diverses en voie de formation ; et de ce conflit général, de cette confusion mécanique, sort le plus souvent un mélange contenant un peu de tout ce qui a pu se former en route ! La température s'est quelquefois élevée de plus de 100°, l'état naissant de certains corps associés aux énergies calorifiques disponibles fait de la réaction totale un vrai chaos ; bien habile le chimiste qui peut prévoir dans ces conditions ce qu'il trouvera dans son creuset !

Nous pensons avoir démontré par tout ce qui précède que la chimie trouvera dans l'étude parallèle des réactions et des conditions thermiques qui les sollicitent, un terrain d'une fécondité inattendue et qui permettra de diriger les recherches d'une façon tout à fait méthodique. Avec les basses températures réglables à volonté, on oblige tous les agents chimiques à garder le silence, on les musèle ; en laissant progressivement remonter la température et en portant dans le milieu refroidi une source d'energie sous forme d'un excitant, on permet à chaque corps d'opérer à son tour, par ordre de puissance.

Les combinaisons s'opèrent ainsi d'une façon rationnelle et prévue. On part d'un noyau primitif pour arriver au corps cherché, sans craindre des dégâts produits accidentellement par le conflit chimique.

Nous croyons que le rôle des basses températures pour les synthèses chimiques ressort clairement des hypothèses que nous avons exposées au début de ce travail et qui semblent de plus en plus se confirmer par l'étude expérimentale.

VII.

Après avoir suivi notre hypothèse et étudié ses conséquences en astronomie, physique et chimie, nous devons, toujours par les mêmes méthodes, poursuivre nos investigations dans l'ensemble des phénomènes biologiques.

Nous avons vu que les phénomènes totaux de la matière morte peuvent être ramenés à l'équation de Newton, complétée par les lois de l'attraction de la matière pondérable s'exerçant sur l'éther.

La vie et ses manifestations caractéristiques peut-elle rentrer dans le cadre de ces conséquences synthétiques, découlant directement de notre hypothèse fondamentale . . . c'est la question.

Précisons le problème en fixant nettement les phénomènes spéciaux, distinguant l'apparition non équivoque de la vie. La somme de ces caractères spéciaux servira de définition à la vie.

1° Tous les êtres vivants, plantes ou animaux,

nous apparaissent sous forme de types spéciaux appelés espèces. Le nom de l'espèce doit accompagner n'importe quel être connu, vivant ou mort.

L'étude des transformations successives des espèces, ou le darwinisme, ne fait qu'illustrer ce fait général.

2° Chaque individu représente toujours une unité ayant une valeur intrinsèque.

3° La conscience de sa propre existence par l'individu n'est pas nécessaire ; chez les animaux supérieurs et chez l'homme en particulier, elle est le fait normal.

4° Les phénomènes physico-chimiques qui se passent dans la profondeur des tissus des êtres vivants paraissent constituer comme résultante un état d'équilibre stable qui correspond à la vie normale des êtres et garantit leur individualité contre la somme des forces extérieures.

5° La vie normale des êtres représente toujours trois phases : la naissance et la croissance jusqu'à l'âge adulte, la vie normale, la vieillesse se terminant par la mort.

6° Les maladies, dans le sens le plus général du mot, sont produites par toutes les influences quelconques qui troublent l'équilibre stable des phénomènes vitaux, au delà des limites qui peuvent être assignées comme normales.

7° Les phénomènes vitaux eux-mêmes, ramenés à leur expression la plus simple, sont toujours caractérisés par des phénomènes chimiques et pas physiques.

Pour les plantes on trouve la cellule absorbant sous l'influence de la lumière l'acide carbonique de l'air ou de l'eau et le décomposant en carbone fixé et en oxygène rendu à l'extérieur.

Pour les animaux, on distingue aussi la cellule absorbant l'oxygène de l'air et le fixant aux substances qui s'introduisent dans cette même cellule par endosmose.

La nutrition et la respiration des cellules, voilà les deux phénomènes constants chez tous les êtres vivants.

Tous les mouvements volontaires ou non, toutes les perceptions sensorielles dues au système nerveux, sont des caractères variables et peuvent complètement faire défaut sans que la vie puisse être considérée comme absente ou éteinte.

Après avoir rappelé, dans ce qui précède, les faits qui nous paraissent dominer la biologie et qui doivent partout et en toute occasion se manifester pour qu'on puisse dire avec certitude, il y a là un phénomène vital, nous allons voir de quelle façon on peut organiser les recherches sur l'influence spéciale de basses températures sur les phénomènes vitaux.

Dans les expériences progressives du froid sur la série des différentes espèces animales il faudra noter l'ordre dans lequel les principales fonctions se modifient.

Pour les êtres supérieurs on devra en particulier enregistrer avec soin :

1° L'état mental, l'action de la volonté, de la mémoire, les perceptions diverses, la vitesse des mouvements réflexes, la valeur de l'erreur personnelle pour l'homme, les variations dans l'intensité des sensations, les limites du pouvoir musculaire, l'anesthésie progressive de la peau, etc.

2° Pour les êtres chez lesquels le contrôle des phénomènes psychiques est impossible, il faut surtout s'attacher aux mouvements observables des différents éléments mobiles ; cils vibratiles, mouvements réflexes dus à la douleur et aux excitations électriques, dilatation de l'iris, mobilité des membres, mouvements péristaltiques de l'intestin, etc.

3° Autant que possible, il faudra aussi enregistrer les effets produits par le même milieu refroidi au même degré sur le même type, type d'animal pris dans les trois phases caractéristiques de sa vie, jeunesse, âge mûr, vieillesse.

On constatera ainsi les points faibles de chaque phase et l'action spécifique des basses températures sur l'organisme s'accentuera encore davantage.

4° Au fur et à mesure que l'on descend dans la série des êtres, les mouvements vitaux se simplifient pour en arriver aux actions chimiques élémentaires des cellules. On touche aux infusoires et aux microbes.

Leur développement sous l'influence des basses températures doit être surveillé avec tout le soin que comporte aujourd'hui la microbiologie ; l'effet du froid sur une longue série d'êtres, tous soumis à ces influences perturbatrices, peut être entrepris, grâce à l'extraordinaire rapidité de la reproduction de ces germes, bacilles et microbes !

Les spores, les diatomées desséchées, les foraminifères, et tous ces êtres qui jouent un rôle analogue à celui des graines dans le règne végétal, peuvent donner lieu aux expériences les plus concluantes sur certains problèmes de la vie, que nous exposerons comme conclusion de ce mémoire.

Expériences sur les Végétaux Vivants.

De même que pour les animaux, nous devons tracer le cadre des expériences concernant les plantes et tous les végétaux.

Pour chaque plante, depuis le sommet de l'échelle, avec les dicotylédones, les marronniers,

les chênes, au bas de l'étage des cryptogames et des algues, il faut examiner avec précision les variations des phénomènes vitaux dus au refroidissement.

Dans cette catégorie d'êtres on trouve les mêmes règles et les mêmes faits que pour les animaux :

Les plantes munies de leurs feuilles et en pleine floraison sont aussi frileuses, si ce n'est plus, que les mammifères les plus délicats !

Si on les plonge, même un peu de temps, dans l'atmosphère glacée, elles périssent avec une vitesse effrayante.

Il est donc nécessaire de graduer le froid et son intensité avec non moins de précautions que pour les animaux.

L'observation simultanée de l'action de la lumière du soleil sur la chlorophylle et celle de la chlorophylle sur l'acide carbonique au même instant, est de la plus haute importance, car c'est le phénomène capital caractérisant la vie végétative des plantes. L'observation des effets du froid sur les racines, les bourgeons, les fleurs, l'évaporation, etc., devra être consignée pour les différents états d'âge des végétaux. Enfin une étude toute spéciale de l'action des grands froids sur les graines permettra de rapprocher dans une même série d'observations les végétaux à leur origine et les animaux en germes.

J'ai pensé qu'il convenait, avant d'attaquer ces problèmes en coupe réglée, de faire ce que l'on fait pour les mines, on force des puits de sondage en différentes places pour connaître la puissance du filon ; ensuite on ouvre les galeries.

En tête du questionnaire que chaque homme porte comme bagage, toute sa vie durant, on trouve toujours quelque question ayant un caractère philosophique, sur le confin de la métaphysique et de la science pure. Une de ces interrogations puissantes est celle-ci : Qu'est-ce que la vie ? D'où vient-elle ? Est-ce quelque principe spécial tombé, on ne sait d'où, spontanément sur terre et qui, tout à coup, a organisé la matière, créé ces types divers, donné à chaque être ce pouvoir mystérieux de procréer lui-même de nouveaux êtres semblables à lui !

La vie peut-elle être appelée spontanément dans la matière inerte ?

La vie a-t-elle pour emblème ce feu sacré des vestales brulant toujours sur l'autel ?

Si ce feu vient à s'éteindre, comment le rallumer ?

Ce problème de la vie est un des plus anciens ; il reste toujours un de plus modernes ; on peut dire cependant que la solution a fait un pas en avant sous l'influence des basses températures et de leur emploi méthodique en chimie et en biologie.

Nous allons d'abord exposer les résultats généraux obtenus durant des recherches qui remontent déjà à bien des années et s'échelonnent de 1869 à 1891. Une partie de ces expériences ont été faites en collaboration avec MM. Casimir de Candolle, Edouard Sarasin et E. Yung, du Bois-Reymond, Bertin, Susani, etc.

D'autres, toutes récentes, complètent quelques termes de la série.

Résultats expérimentaux.

Mammifères supérieurs. Le chien a été l'animal choisi pour quelques recherches.

Un chien de taille moyenne pesant 8 kilogrammes et demi environ, à poils ras, est placé dans le puits frigorifique refroidi à $-90°$, $-100°$, les appareils fonctionnant de telle sorte que cette température est constante.

Le chien est placé sur un fond de bois garni d'un sac de toile. Sa queue et son museau ne touchent pas les parois métalliques du puits, tendues à l'intérieur d'un cylindre de toile formé par les parois d'un grand sac relevées tout autour de l'animal.

Dans cette expérience un thermomètre est fixé dans l'aine du chien, dont la patte de derrière est solidement fixée contre l'abdomen avec plusieurs doubles de flanelle.

La peau ayant été rasée, un excellent contact est établi entre le réservoir du thermomètre, ayant une forme cylindrique, et la circulation générale de la bête, la flanelle et la position du chien font que le réservoir du thermomètre occupe à peu près la position centrale du puits frigorifique et qu'elle se trouve très protégée contre le rayonnement. La tige du thermomètre est assez longue pour permettre des lectures continues à 35 centimètres au-dessus du chien.

Voici maintenant les observations générales recueillies. Nous ne donnons pas de chiffres de détails, nous en tenant seulement à la marche des phénomènes.

La température du chien étant normale et l'animal ayant mangé deux heures avant le début de l'éxpérience, on introduit le chien dans le puits refroidi à $-92°$.

Dès la première minute on observe une augmentation progressive de la rapidité de la respiration et de la fréquence du pouls.

Ces accélérations vont en s'accusant pendant 12 à 13 minutes, à mon étonnement je constate d'abord au thermomètre une augmentation de température d'environ un demi-degré.

L'animal donne des signes d'agitation.

Après 25 minutes, la température est lentement revenue à son point de départ.

Le chien mange avec avidité du pain qu'il refusait péremptoirement avant le début de l'expérience.

La respiration est toujours très active, fréquente et profonde.

Après 40 minutes les extremités des pattes sont très froides, mais la température s'est maintenue à peu près constante, oscillant avec deux à trois dixièmes de degré près autour de +37°.

Après 1 heure 10 minutes, le chien ne marque plus d'agitation sensible, mais respire fort et tend à faire quelques mouvements avec les pattes maintenues par les cordes, efforts suivis de calmes complets, sauf la respiration.

La circulation est un peu plus rapide que précédemment, on sent les pulsations du cœur bien nettes à l'artère carotide.

Les extrémités se refroidissent encore plus.

Pendant la demi-heure suivante la bête a mangé environ 100 grammes de pain et les conditions générales indiquées plus haut ont varié. La temperature s'est abaissée d'un demi-degré tout au plus.

Tout à coup, en quelques instants, la respiration se ralentit, le pouls devient fuyant et la température s'abaisse avec rapidité.

Vers 22° on retire l'animal sans connaissance du puits et tous les soins pour le rappeler à la vie sont inutiles.

L'extrémité des pattes est déjà gelée.

Le chien est mort en moins de deux heures par rayonnement de sa chaleur, et par les effets perturbateurs causés par ce refroidissement excessif.

D'autres animaux, chiens et cochons d'inde, ont toujours manifesté dès leur entrée dans le puits frigorifique, cette augmentation dans la fréquence de la respiration et des battements du cœur ; dans les cas observables, une légère élévation de la température intérieure s'est toujours produite.

Nous pouvons conclure de là que l'équilibre stable des mammifères vivants provoque dans l'organisme normal, en face de ce facteur subit, une réaction formidable. Lorsque l'individu menacé perd sa chaleur par rayonnement avec une telle énergie, il semble que la conservation automatique de l'animal provoque une absorption d'oxygène plus que normale ; les fonctions de la digestion repartent avec vigueur et, à la menace des effets du froid, les organes répondent par un travail inverse : une surproduction de chaleur et d'énergie.

Probablement que les tissus connectifs, graisses, etc., se réabsorbent rapidement pour donner au sang les principes hydro-carburés attaqués par l'oxygène ; l'apparition de la faim a toujours été signalée après un quart d'heure d'expérience.

Lorsque la déperdition de chaleur devient toujours plus considérable, l'individu organisé inconscient fait le sacrifice des membres périphériques. La circulation s'arrête dans toutes les extrémités, elles sont mortes les premières.

Puis, presque tout à coup, la circulation centrale s'arrête elle-même, lorsque l'abaissement de la températures est à 8° à 10° au-dessous de la normale. La chute finale brusque indique et prouve l'énergie du combat engagé par l'individu vivant contre le facteur qui vient perturber l'équilibre vital.

Une étude approfondie de ces phénomènes reste à faire, car elle est d'un enseignement capital relativement à certaines fonctions du système nerveux central, et sur les causes de la combustion lente dans la circulation sanguine.

Refroidissement d'un Organe.

J'ai essayé sur moi-même l'effet du refroidissement de la main par rayonnement.

J'ai plongé le bras nu jusqu'au-dessus du coude dans le puits frigorifique maintenu à −105° sans toucher les parois métalliques.

On sent sur toute la peau et dans toute l'épaisseur des muscles une impression tout à fait caractéristique et spéciale qu'aucune description ne peut faire entendre. On éprouve une sensation, pas désagréable d'abord, mais qui le devient peu à peu et dont le siège a l'air d'être l'os central ou le périoste.

Le mot "se refroidir jusqu'à la moelle" semble prendre une signification nouvelle et vécue. Au bout de 3 à 4 minutes la peau du bras est un peu violacée, mais la douleur devient forte et gagne surtout les parties profondes. Au bout de 10 minutes, après avoir sorti le bras du puits frigorifique, on éprouve en général une forte réaction avec cuisson superficielle de la peau.

En maniant longtemps de la neige avec les bras nus, la réaction cutanée subséquente ressemble, en plus affaibli, à cette cuisson qui apparaît à la fin de l'expérience décrite.

Expérience sur les Poissons.

Les poissons rouges, les tanches et généralement les poissons d'étangs d'eau douce peuvent être complètement gelés puis dégelés sans mourir. L'expérience demande cependant à être faite avec ménagement.

Si l'on congèle lentement, dans une atmosphère de $-8°$ à $-15°$, des poissons de cette catégorie, en ayant eu la précaution de laisser ces poissons quelque vingt-quatre heures dans de l'eau à 0°, on peut former un seul bloc compact de cette eau et des poissons qu'elle contient.

En brisant une partie de la glace et mettant à nu un de ces animaux, on constate qu'on peut le casser en petits morceaux comme s'il était lui-même fait de glace.

On peut donc admettre que tous les poissons du même bloc ont la même apparence intérieure et qu'ils sont tous gelés au même degré.

En laissant lentement fondre cette glace et les poissons qu'elle renferme, on voit ceux-ci nager après comme avant sans aucun signe de malaise apparent.

Au-dessous de $-20°$ l'expérience ne réussit plus avec les poissons rouges et les tanches.

Nous n'avons pas examiné encore la série des poissons à cet égard.

Expériences sur les Batraciens.

Les grenouilles subissent un refroidissement et une congélation de $-28°$ sans crever.

A $-30°$ et $-35°$ la plupart cessent de vivre.

Expériences sur les Ophidiens.

J'ai refroidi un serpent commun des champs appelé vulgairement lanwoui, à $-25°$, il a survécu, mais, refroidi à $-35°$, il est mort.

Expériences sur les Scolopendres.

J'ai refroidi à $-40°$ trois scolopendres qui ont parfaitement résisté au traitement et ont vécu une fois dégelés.

Soumis à $-50°$ ils ont aussi résisté.

Refroids une troisième fois à $-90°$ ils sont morts tous les trois.

Expériences sur les Escargots.

Ayant refroidi trois escargots, fournis par M. le prof. E. Yung de l'Université de Genève, dont deux présentaient quelques fissures à la plaque fermant leur coquille, nous les avons refroidis à $-110°$ à $-120°$ pendant bien des jours.

Les deux escargots légèrement fendus sont morts, celui qui était intact a survécu au traitement et a échappé à la mort, grâce probablement à son opercule intact.

Expériences sur les Œufs d'Oiseaux.

Tous les œufs d'oiseaux refroidis au-dessous de $-2°$ à $-3°$ meurent et ne peuvent être couvés ; si on ne les refroidit que jusqu'à $-1°$, ils survivent.

Expériences sur les Œufs de Grenouilles.

Ces œufs, refroidis lentement à $-60°$, peuvent revivre et donner éclosion aux têtards. Si le refroidissement est brusque ils meurent. Il est très essentiel de mettre au minimum plusieurs heures pour obtenir l'abaissement complet de la température.

Expériences sur les Œufs de Fourmis.

Ces œufs, pris pendant la saison chaude, sont très sensibles au froid.

Suivant l'état d'avancement de la larve de l'insecte dans l'œuf, le refroidissement peut être plus ou moins grand.

Entre 0° et $-5°$ tous les œufs ont été tués. Nous avons eu aussi des œufs avancés, tués par une température de $+5°$ maintenue quelques heures.

Expériences sur les Œufs de Ver-à-Soie.

Nous avons fait un très grand nombre d'expériences, grâce à une installation industrielle que nous avons organisée en Italie septentrionale, pour la conservation des graines de ver-à-soie.

Ces œufs sont assez résistants, surtout si dès la ponte ils n'ont jamais eu de commencement de développement. Lorsque ces œufs pondus sont placés immédiatement dans la chambre froide, on peut les refroidir à $-40°$ sans leur faire perdre leur pouvoir de développement. Il se passe même dans ce cas un phénomène intéressant : les œufs refroidis, puis soumis aux conditions de température normale pour leur éclosion, dès que le printemps a garni les mûriers de leurs feuilles, ne présentent presque jamais les maladies si fréquentes aux œufs de vers-à-soie abandonnés à eux-mêmes et subissant plusieurs mois durant les fluctuations des températures ambiantes.

Les parasites de toutes espèces, vrais microbes des œufs du ver, ne trouvent pas, dans ces conditions, un terrain favorable à leur développement, et la chenille sort indemne de tous ces accidents si redoutables pour elle et si redoutés par toute l'industrie de la soie.

Le refroidissement artificiel des œufs de ver-à-soie est entré dans la grande industrie, vu ces avantages bien positifs.

Du reste tout ce travail découle directement des belles recherches de Pasteur sur les vers-à-soie.

Expériences sur les Infusoires.

Des rotifères, et toute la série ordinaire des infusoires qui se développent normalement par le séjour de quelques durée de végétaux dans l'eau stagnante, ont été gelés dans l'eau où ils pullulaient, puis abaissés à $-80°$ et $-90°$

A cette température, maintenue pendant près de 24 heures, une grande partie des habitants sont morts.

A $-60°$, au contraire, ils ont tous vécu, autant que leur dénombrement était possible.

Une dernière expérience faite à $-150°$, $-160°$ n'a plus laissé dans l'eau dégelée que des cadavres.

Expériences sur les Protozoaires, les Microbes et les Graines, les Diatomées, etc.

Grâce à l'obligeance de M. Casimir de Candolle et de quelques autres naturalistes, j'ai pu me procurer à différentes reprises des graines sèches en bon état d'une foule de plantes diverses.

De même, grâce à plusieurs zoologistes: MM. Fol, Miguel, E. Yung, MM. Pasteur et Roux de Paris, M. le Professeur Koch de Berlin, etc., j'ai pu rassembler une collection complète de microbes, de diatomées, de micrococques, de bacilles, de spores, dont la nomenclature serait ici fastidieuse.

Plus de 30 à 35 espèces de microbes, un plus grand nombre de graines, de diatomées, etc., ont été soumis, dans une série d'expériences, à des températures de plus en plus basses.

Une partie de ces recherches ont déjà été publiées dans les archives, les dernières expériences faites à Berlin sont encore inédites.

Dans toutes ces recherches, sans exception aucune, les refroidissements les plus excessifs et les plus prolongés ont donné des résultats négatifs; c'est-à-dire que les germes, graines, microbes, spores, bacilles, diatomées, micrococques etc., se sont tous développés après ces refroidissements comme ils le font normalement, sans aucune différence appréciable.

Les spores ont donné naissance à toute la série de leurs bacilles, les diatomées ont émis leurs filaments protoplasmiques ou pseudopodes, les graines ont germé et poussé des bourgeons et des plantes vigoureuses, etc. En un mot, les graines et les œufs des animaux, qui leur servent de parallèles dans l'autre règne, semblent défier les froids les plus intenses.

Dans la dernière série d'expériences, les graines et les bacilles ont été placés à près de $-200°$ dans l'air liquéfié et se sont développés de la même façon que les mêmes graines et germes conservés aux températures extérieures.

Les cils vibratils du palais des grenouilles, soumis aux mêmes expériences, ont cessé de vibrer lorsque le froid a dépassé $-90°$. Une fois réchauffés et dégelés ils recommençaient à exécuter leur mouvement pendulaire.

Les vaccins seuls et les cultures connues sous le nom de ptomaines, à l'exception de toutes les substances organisées, semblent beaucoup souffrir des grands froids. Les vaccins deviennent stériles.

On sait du reste que les vaccins ne contiennent pas de microbes ni de spores.

L'influence des basses températures trace ainsi une ligne de démarcation intéressante entre ces grandes classes de substances virulentes: les microbes et les vaccins.

Conclusions.

Il se dégage de cette première série d'observations, encore bien incomplète et remplie de lacunes, quelques conséquences générales que nous essayerons de résumer ici:

1° Il est certain que plus on prend les phénomènes vitaux à leur origine, dans les organismes les plus simples et les plus primitifs, plus le refroidissement peut être poussé loin, sans amener plus tard de modifications appréciables dans le développement des individus refroidis.

2° En formant une échelle des êtres, depuis les plus inférieurs jusqu'aux mammifères, on constate qu'une échelle analogue établit les températures minima que ces êtres peuvent supporter.

Au fur et à mesure que l'organisation se complique, les froids intenses deviennent plus à redouter pour l'individu.

3° Chez les animaux supérieurs le refroidissement brusque dans un bain d'air froid provoque une réaction énergique, très caractéristique et qui pourra peut-être conduire à des méthodes thérapeutiques utiles à l'homme dans certaines maladies.

4° Enfin une conclusion d'un ordre philosophique se dégage de cet ensemble de faits relativement aux idées générales qu'on peut se faire sur la vie.

Nous avons démontré qu'aux basses températures voisines de $-100°$ tous les phénomènes chimiques, sans aucune exception, sont anéantis et ne peuvent plus se produire. Donc les actions chimiques qui, par principe même et définition, doivent se manifester dans la profondeur des tissus, pour que nous puissions y reconnaître la présence de la vie, sont supprimées *ipso facto* à $-200°$ dans tous les germes, graines, spores, etc.

Nous nous trouvons ainsi au moment où l'on réchauffe ces organismes refroidis à $-200°$, dans d'excellentes conditions pour caractériser un des côtés principaux de la vie, à savoir si elle prend naissance spontanément dans un organisme mort préexistant.

Si la vie, semblable au feu des vestales, devait

disparaître à jamais de l'organisme une fois qu'on l'aurait laissée s'éteindre, ces germes une fois morts (et ils le sont à $-200°$) devraient rester morts ! Au contraire, ils vivent, ils se développent comme si ce refroidissement n'avait pas eu lieu.

Donc la vie est une manifestation des lois de la Nature au même titre que la gravitation et la pesanteur. Elle est toujours là, elle ne meurt jamais, elle demande pour se manifester l'organisation préexistante. Celle-ci obtenue, chauffez, mettez l'eau, la lumière, et de même qu'une machine à vapeur dans ces conditions se met à fonctionner, le germe vivra et se développera.

On sait que jusqu'à ce jour, ni spontanément, ni artificiellement, l'homme n'a jamais vu sous ses yeux se former ce premier organisme où la vie jaillit comme d'un puits artésien. Pour créer cet organisme, il faut nécessairement s'adresser à la vie, et voilà pourquoi le cercle est encore vicieux, la question reste ouverte.

Si l'on pouvait créer de toutes pièces une structure organisée morte, les conditions physico-chimiques suffiraient pour y développer tous les phénomènes vitaux de la vie végétative.

L'étude des phénomènes vitaux par l'emploi méthodique des basses températures permet donc de faire rentrer la vie au nombre des forces constantes de la Nature.

VIII.

Nous en arrivons maintenant à l'examen des phénomènes psychiques.

On peut affirmer qu'aucun phénomène sensoriel conscient caractéristique du monde psychique ne peut s'observer sans l'existence préexistante d'un système nerveux chez l'individu observé. Les arbres, les muscles, les cils vibratils mêmes sont le centre de phénomènes biologiques mais nous ne retrouvons aucun symptôme de pensée.

Les animaux seuls et surtout les animaux supérieurs, les mammifères sont le siège constant de ces phénomènes sensitifs et psychiques.

Nous savons que tous les organes des centres nerveux congelés à basse température, ne présentent plus aucun phénomène psychique ; toutes les réactions sont supprimées totalement endormies.

Par l'examen direct des animaux soumis à de très basses températures quelques uns seuls ont repris vie. Les escargots, quelques serpents, les œufs de papillons, quelques poissons mêmes ont survécu.

Nous pouvons donc affirmer que la mort de la vie intellectuelle et psychique est le cas général quand l'organe des centres nerveux a été refroidi puis réchauffe ; mais nous constatons aussi des modifications profondes et traumatiques dans la structure élémentaire des éléments constitutifs des tissus.

Les cellules ont éclaté par congélation et au réchauffement suivant les basses températures, elles n'ont point été réparées.

Ainsi l'organe ayant été maltraité, la question de la suppression des phénomènes psychiques ou de leur réapparition dans un organe sain d'une façon spontanée après le réchauffement reste ouverte. Pour les serpents, les escargots et les infusoires et en somme une foule d'espèces d'animaux inférieurs, l'intensité des constations psychiques est plutôt faible, mais ils ont des sens déjà assez développés et des instincts très surs. Outre cela ils savent se diriger, choisir leur chemin et montrent souvent des combinaisons très intelligentes dans leurs actes.

Si on peut donc affirmer que la vie intellectuelle ou psychique de ces êtres a repris spontanément avec la reprise des phénoménes physico-chimiques qui se passent dans la profondeur des centres nerveux, il faut admettre qu'ils sont plus résistants que ceux des êtres supérieurs et ne se laissent pas désagréger par les basses températures.

Par induction, mais sans aucune certitude, on pourrait en conclure que si un homme pouvait être réfroidi à $-200°$ et ensuite réchauffé sans avoir perdu la vie végétative, les phénomènes psychiques se représenteraient comme en temps normal et cela en proportion de l'état indemne dans lequel on retrouverait les centres nerveux. La vie psychique, c'est-à-dire l'âme, reprendrait possession de son centre naturel avec tous ses caractères.

A ce sujet il est important de ne laisser aucune méprise se glisser dans ces conséquences tirées d'expériences scientifiques.

Nous affirmons hautement ici que l'âme est une personnalité pensante habitant un milieu spécial, mais n'est pas le milieu.

L'âme n'est pas une chose, mais nous ne la connaissons que lorsqu'elle se manifeste dans une chose : le cerveau.

Voici une comparaison qui fera bien comprendre toute notre pensée.

Voyez ce télégraphe automatique tel qu'on le rencontre dans tous les hôtels à Londres et ailleurs ; vous entendez un déclic et l'appareil se met à marcher, il enrégistre sur une bande de papier les nouvelles à chaque instant.

Eh bien, le télégraphe et le papier sont la chose, et sont l'équivalence du cerveau.

Le sens de la dépêche en est l'âme !

Ce sens habite dans l'appareil, est compris dans les caractères et l'outil merveilleux qui imprime les lettres des phrases. Mais le sens est impondérable, invisible, compris seulement par l'être immatériel qui habite en nous.

Si le télégraphe est détraqué le sens ne sort plus ou sort mal avec des erreurs, des omissions, des fautes.

Si le télégraphe est refroidi il ne marche plus, vient on à le réchauffe il repart, alors le sens des dépèches reparait dans le texte.

L'âme est aussi une manifestation perpétuellement présente dans son organisme en bon état..

La manifestation est synchrone avec le bon fonctionnement de l'appareil, mais a une essence absolument différente.

Telle est la conclusion qui se dégage de cet ensemble d'expériences.

Conclusions générales.

Résumons maintenant les grandes lignes de l'étude des phénomènes cosmiques que nous venons de rappeler.

Tous les phénomènes sont ramenés à être fonction d'une seule variable, la distance qui sépare les éléments matériels qui constituent tous les corps connus.

L'éther enveloppe tous ces éléments et permet tous les mouvements oscillatoires et vibratoires des particules physiques et chimiques des corps.

Aux grandes distances on étudie les phénomènes astronomiques dans lesquels l'éther ne perturbe pas la loi de Newton.

Avec les points critiques en astronomie on précise au millimètre, l'ellipse d'une comète périodique ou d'une planète, et la trajectoire hyperbolique qui permet d'affirmer que l'astre est une voyageuse sans retour.

Aux distances petites, l'éther intervient et permet aux mouvements oscillatoires des particules de réprésenter le mode des phénomènes calorifiques et lumineux.

L'analyse spectrale nous renseigne sur les qualités essentielles des particules en mouvement, car par le spectre nous avons les longueurs d'ondes lumineuses provenant d'atomes ou de molécules ayant un certain poids et une attraction correspondant à leur volume et à leur masse.

Chaque corps a donc son spectre.

Le point de fusion des corps solides est équivalent au point critique en astronomie. Les molécules solides deviennent liquides en abandonnant le système rigide auquel elles appartenaient.

Les phénomènes de dilatation, de conductibilité, d'élasticité, etc., découlent tout naturellement de notre théorie.

Les changements d'état liquide en état de vapeur nous donnent un autre point critique pour la rupture de la molécule liquide et sa transformation en molécules ou atomes gazeux.

L'expérience démontre surabondamment la précision des distances ou des températures correspondant à ces points critiques des liquides.

Enfin nous sommes arrivés aux phénomènes chimiques qui prennent naissance par un effort négatif extérieur forçant les particules à pénétrer plus avant dans leur sphère d'attraction.

La molécule ou l'atome absorbe toujours de l'énergie pendant la première partie de cette contraction, l'atome passe par un état d'équilibre instable et tombe spontanément dans la position acquise après la réaction en produisant de l'énergie. Les réactions se partagent ainsi toutes en réactions exothermiques, produisant de la chaleur et en réaction endothermique, c'est à dire absorbant de la chaleur.

Les basses températures arrêtent toutes les réactions sans aucune exception.

Ce fait devient donc le critère spécial qui permet de distinguer un phénomène chimique d'un phénomène physique.

Le phénomène physique, chute d'une pierre, élasticité d'un ressort, couleur, etc., continue malgré les basses températures.

Les réactions chimiques ont leur point critique aussi marqué que les points critiques astronomiques et physiques. Les phénomènes vitaux sont perturbés mais pas supprimés par l'application des basses températures aux êtres vivants non abimés par la congélation.

Les phénomènes psychiques survivent aux basses températures lorsque les organismes résistent.

Ainsi en prenant la théorie de Newton et en lui appliquant les effets de l'attraction de la matière pour l'éther aux faibles distances on reconstitue une immense Astronomie moleculaire aussi précise, aussi exacte que l'astronomie astrale.

J'ai été l'humble élève des Newton, Kelvin, Helmholtz, Clerk-Maxwell, et je vous ai apporté, Messieurs et chers Collègues, le résultat de mes méditations sur le grand problème du monde dans lequel nous vivons, souffrons et mourons.

The Chairman said it would be agreed that this was not an occasion for a discussion; but a pleasant duty remained to be performed, especially as M. Pictet had travelled all the way from Berlin to be present on this occasion, namely, to propose a very hearty vote of thanks to him for his eloquent lecture.

Sir WILLIAM RAMSAY, K.C.B., F.R.S., seconded the vote of thanks. It had been most interesting to hear the Professor expound those fundamental ideas. If there had been time it would have been of interest to ask him if he could not extend his ideas not only to the attraction between element and element to form compounds, but to the attractions which formed the elements themselves. All would join in expressing the gratitude of the Society to the lecturer for his excellent exposition.

The resolution was carried and the meeting terminated.

EXAMINATION FRAUDS.

At Bow-street, on Saturday, the 13th inst., two cases were heard before Mr. Curtis Bennett, in which certain teachers were charged with improperly obtaining prizes in the Society's examinations.

The first case was that of JAMES T. HUGHES, aged thirty-five, of Birkbeck-avenue, Acton, who was summoned for obtaining a silver medal and £2 from the Royal Society of Arts by false pretences with intent to defraud; and the second was that of W. E. FRASER, of Ampton-street, Gray's Inn-road, who was summoned for obtaining £1 and a silver medal by similar means. Both defendants pleaded guilty.

Mr. BODKIN appeared to prosecute on behalf of the Director of Public Prosecutions, and Mr. TRAVERS HUMPHREYS appeared for the defence, while Mr. J. B. MATTHEWS held a watching brief for Mr. Clark, of Clark's College.

Mr. BODKIN, in opening the case, said it had been undertaken by the Public Prosecutor for the reason that it was of considerable importance to a large section of the community, and because of the standing of the Society. The defendant, James T. Hughes, had been for some time a tutor in arithmetical subjects at Clark's College in Chancery-lane. The Royal Society of Arts, which was the body primarily to suffer, had for some fifty years or more instituted under their charter a system of examinations in subjects connected with commercial life; and in connection with those examinations, and similar examinations of other bodies, there had grown up of recent years colleges or places where commercial education was mainly given, and amongst those colleges was the college to which the defendant had been attached. For the convenience of candidates the Society had localised their examinations at numerous places in the country; and occasionally, when there was a large number of students, the colleges were made local examination centres. A number of rules had been framed for the purpose of securing absolute propriety of conduct on the part of the candidates entering the examinations, and of ensuring that only real and genuine candidates should compete, and be entitled, if successful, to the prizes which the Society of Arts offered to those who attained the highest standard. One of the rules, most clearly expressed, was that no teacher in any institution where an examination centre existed would be admitted to examination at that centre, and another was that no person who had given instruction to any of the candidates in any subject of examination could serve as a superintendent of the examination, and no member or officer of a committee could be admitted to examination. The committee referred to was the local examination committee appointed for the particular examination held in accordance with the Society's rules. In connection with the examination of 1910, held at Clark's College, the usual committee was appointed, and amongst the number appeared the name of the defendant, "J. T. Hughes, Tutor, 15, Birkbeck-avenue, Acton." In addition to the names of the committee, who appeared largely to be persons interested in education, there was the name of the Secretary to the Examination Committee, "R. Sydney Fry, 1, 2 and 3, Chancery-lane."

From every candidate entering the examinations a nominal fee was required—a fee that barely covered the actual outlay necessitated by the examination—and those fees were collected at the local centres, and, together with the number of candidates in each particular subject, were forwarded to the Royal Society of Arts; and from that return the Society knew exactly the number of examination papers to send to the local centres. In 1910 the Society duly received the fees and particulars, and, in pursuance of the rules, forwarded to Mr. Fry, under a sealed cover, the exact number of examination papers required. When the candidates entered the room, persons had to be present to see to the maintenance of order, to distribute the papers, and at the proper time collect them from the students. On the day of the examination, April 12th, 1910, a Mr. Bird also acted as superintendent of the local centre at Clark's College, and the defendant Hughes and others representing the local committee were in the room. On that occasion it was evident that one or more students failed, either from illness or some other cause, to attend, and the defendant, in assisting in distributing the examination papers, helped himself to the paper of an absent candidate, took it into a room adjoining the examination room, and sat down and worked it out in the name of "Harold Nelson." According to the rules of the Society, at the end of the allotted time the examination papers had to be collected and initialled by the superintendent of the examination, and, if too late to post that evening, preserved until the next morning and then posted back to the Society. On the occasion in question, the superintendent apparently did not initial all the examination papers, as he was in a hurry to catch a train. He locked the papers up in his room for the night, and between that time and the next morning, when they were posted, the paper of "Harold Nelson" had been inserted amongst the

papers of the genuine competitors. In June the paper was awarded marks which earned for it a silver medal and a prize of £2. Under their rules the Society took an additional precaution. Before the prize or medal was given, the Society sent to the secretary of the local examination centre—in this case Mr. Fry—certain names of persons on whose papers the examiner had made awards, and amongst those names was that of "Harold Nelson." The document, which was signed by Sir Henry Wood, the Secretary of the Society of Arts, contained the following: "I shall be obliged to you if you will be so good as to let me know on the form attached whether the candidates at your examination centre whose names are given below are eligible for a medal or prize under the Society's regulations." And then followed the regulations in question, amongst which were: "No prize or medal in any subject will be awarded to anyone who is now acting, or has acted, as a teacher in that subject," and "No prize or medal in any subject will be awarded to any person over the age of 23 whose profession or occupation is connected with that subject, unless he or she has been a regular attendant at a class for instruction in the subject for examination during the twelve months preceding the date of examination." Then followed the entry: "Royal Society of Arts Examination, 1910, Clark's College; Name of Candidate, Harold Nelson; Age, 22; Subject, Arithmetic," and then, in the column for the reply, was written by Mr. Fry, "Eligible." After that certificate of eligibility was sent back to the Society, the results of the examination were printed and published, and the name of Harold Nelson appeared among the list of prize-winners, and in September a cheque for £2, signed by Sir Henry Wood on behalf of the Society, and payable to "H. Nelson," was sent to Mr. Fry, together with a silver medal, engraved "Harold Nelson, Advanced Examination, 1910, Arithmetic." If Mr. Fry, before he sent in the certificate of eligibility, had made the least inquiry, that certificate of eligibility would never have been sent. Mr. Fry handed to Hughes the cheque and the medal for presentation to "Harold Nelson," but, of course, they remained in the possession of the defendant. Since the summons had been issued, the medal, together with two sovereigns, had been returned to the Director of Public Prosecutions. The cheque received from the Society was endorsed by the defendant Hughes in the name of the payee. It was not for one moment suggested that the head of Clark's College was in the slightest degree cognisant of what had been going on; in fact, he was away in India when the examination took place, and it was not until the beginning of 1911 that he was apprised of what had been going on. Mr. Clark, the proprietor of the college in Chancery Lane, was also the proprietor of all the many branches set forth in his prospectus, and there was no question that Mr. Clark knew nothing whatever about a very large number of students entering such branches in different parts of London. But for the purpose—quite legitimately—of advertising the advantages of the college, a prospectus was published annually, and in that prospectus, under the heading of: "The Brilliant Display of Clark's College Students at the Last Examinations held, showing how the College made practically a clean sweep of the Highest Honours in the Commercial Examinations, and gained the Highest Awards open to Competition in these Examinations," was a list of "Prizes and Medals gained by our Students." This list included "H. Nelson, Medal and Prize £2, Arithmetic, Society of Arts, 1910." Counsel went on to point out that in the previous year—1909—under precisely the same conditions, the defendant, in the name of "Hugh James," worked and sent in another examination paper, for which he gained the first prize of £3 and a silver medal, and in the prospectus of Clark's College for 1909 the name of "H. James" appeared under the heading of: "The Brilliant Display of Clark's College Students." The prosecution was not undertaken because the Society of Arts felt any grievance at parting with silver medals or money; they felt that their examinations should be preserved absolutely inviolate so far as possible. Hitherto the regulations had been considered to be perfectly satisfactory, but it was possible they might have now to be reconsidered. If tutors were able to take part in the examinations, genuine competitors, whose future in life perhaps depended upon their getting particular diplomas, were placed at a great disadvantage and ousted from that chance. When the matter was discovered, the Society determined, on advice, that the only proper course open to them was to deal with the matter publicly; but they had no feeling in the smallest degree against the defendant individually, and no other desire than to show that people were not allowed, either by the rules of the examinations or by the law, to compete in examinations in a manner which was dishonest to other candidates. The proceedings were taken, in fact, to make it clear that it was a criminal offence, and, having gained that object, the Society respectfully asked the magistrate to deal with the case in such a way as not to make the future of the defendant harder than it otherwise would be. It was understood that Mr. Clark, as soon as he had been communicated with by the Royal Society of Arts, made full inquiries, and acted in the most drastic way, discharging the defendant there and then. Therefore the defendant, in one sense, had been punished, and the prosecution asked his Worship to give the fullest possible weight to that punishment in the decision he might come to, whatever it might be.

Mr. Travers Humphreys, on behalf of the defendant, admitted the seriousness of the offence, but pleaded that the appeal of the prosecution should be taken into consideration, and that the high character which the defendant had always borne, apart from the particular offence, should be allowed to have full weight. He admitted that the facts were exactly as stated by Mr. Bodkin, but

said the defendant had no intention of acting fraudulently. He had only in mind the certificate which anyone might obtain, and which he thought would assist his advancement in the department in which he was engaged. He was greatly surprised to receive a money prize and a medal in 1909. Having found how easily it could be done, he entered again in 1910, but on that occasion was not so successful, as he only obtained the second prize, the first being obtained by a student at the college. He asked the magistrate to take the view that the offence was not committed for the sake of the small monetary prize, but with the view—improper, of course—of securing his own advancement with Mr. Clark. Should the magistrate take a lenient view, there was a chance that Mr. Clark would take the defendant back into his employment, or assist him by such references—of course, apart from this matter—as would enable him to obtain some other employment in the future.

Mr. Curtis Bennett said the defendant had done not only, as counsel said, a very mean thing, but a very dishonourable thing. Defendant was quite old enough to appreciate the results of his actions and deeds, and he (his Worship) could not for a moment think he did not know from the very first—from the time he began to put his pen to paper—that he was doing something he had no right to do, and that, in obtaining something he was not entitled to obtain, he was depriving other people who had gone in for the examination from obtaining what was due to them. The prosecution had been very properly taken up by the Public Prosecutor, because if such things were allowed to go on, the value of the examinations would be at an end. The Public Prosecutor, through Mr. Bodkin, had pointed out in detail all the wrong which naturally followed from the course of conduct the defendant had adopted. It was probable that the mere value of the money prize was not so attractive to the defendant as the academic value of the honour of obtaining a medal and being in the list of prize-winners, and that seemed to explain the loss of the defendant's power of appreciating between right and wrong. The learned counsel for the prosecution had not only pointed that out, but had in exceptional terms asked that as lenient a course as possible should be taken in the case, and Mr. Humphreys had mentioned that if a lenient view were not taken, it would have the effect henceforth of depriving the defendant of the means of obtaining a living in the only profession in which he had been educated—namely, that of teaching. It had been further stated by learned counsel that justice having been done by bringing the defendant into Court, there might be a possibility of finding some employment for him by which he could earn a livelihood. Of recent years an enormous change had taken place in the awarding of punishment. Years ago, when he was first called to the Bar, sentences of penal servitude and of long terms of imprisonment were very common; but during the last twenty-five years there had grown up a system by which, instead of sentencing people to terms of imprisonment, an endeavour was made, if possible, to lead them to their own reformation while on probation. During the time he had been a magistrate he had, from the very commencement, on all occasions taken that course where he thought it was probable the result would be that the person charged would not again give way to temptation, but would lead an honest, honourable, and straightforward life. He had been assured by defendant's counsel that the defendant had determined, whatever sentence was passed upon him, he would never again be tempted to obtain that which he had no right to obtain, and would never again be guilty of a dishonourable action. It was but right that the public should know that such conduct could not, and would not, be tolerated, and that, should it unfortunately occur again, the present case would be remembered, and the punishment would probably not be the same as he was about to award the defendant. Taking all those facts into consideration, he should order the defendant to find two sureties in £100 each, and to enter into his own recognisances of £200 to come up for judgment if called upon within the next two years. If the defendant's actions in future were what they should be, he would hear no more of the matter, but should he give way again, he would have to appear before the Court, when it would be his (the magistrate's) duty to pass sentence upon him.

The recognisances were entered into at once.

The second case was that of William Edward Stuart Fraser, Tutor, of Ampton-street, Gray's Inn-road, who pleaded guilty to a charge of obtaining a cheque of £1 and a silver medal from the Royal Society of Arts by false pretences in the year 1909.

Mr. Bodkin outlined the case, which was of a somewhat similar character to the last. The defendant was employed at Clark's College, in Chancery-lane, as a tutor in arithmetic, and was also a member of the local examination committee, and sent in an examination paper under the name of "W. E. Stuart," and as "W. E. Stuart" was advertised under the heading of "The Brilliant Display of Clark's College Students during 1909." Counsel thought the cases of both Hughes and Fraser showed there was very gross carelessness at the college, seeing that certificates of eligibility were issued with regard to fictitious students, and names published in the prospectus of the college of persons who were never students at all. He did not wish to make the slightest suggestion with regard to Mr. Clark himself, who necessarily had to leave, in such a very large business, the details to heads of departments. Mr. Clark had taken the very proper course of cancelling the inaccuracies in the prospectuses for 1909 and 1910, but the names of "Hughes" and "Fraser" still

appeared in connection with other examinations in the prospectus for 1911, and it was quite wrong to continue to publish the names of two paid tutors of the college as having gained successes as students. He hoped that would be remedied. Mr. Bodkin made the same appeal for leniency on behalf of the present defendant as he had made on behalf of the defendant Hughes.

Mr. TRAVERS HUMPHREYS said when the defendant entered in 1909 for the examination, he had no idea that he would obtain anything more than a certificate, and it was to his credit that, having done it in that year, he did not take the opportunity of doing it again in 1910.

Mr. CURTIS BENNETT said the defendant was in Court, and heard the decision in the last case, and he need not repeat what he had then said. The sentence would be of a similar character to that which had been passed upon Hughes, but having regard to the somewhat lower position the defendant occupied, he should be content to bind him over for twelve months on the defendant's own recognisances in the sum of £50 and one surety in £50, or two in £25. Referring to Mr. Bodkin's remarks with reference to Clark's College, he desired to say he entirely agreed with those observations. From the way in which Mr. Clark had behaved in the matter, he felt sure he would see at once that all reference to the success of students so far as the two defendants were concerned would be deleted from advertisements appearing in the papers.

The recognisances were entered into.

Mr. CURTIS BENNETT said he understood the money had been returned, and he would make an order that the medals should be returned also.

Mr. J. B. MATTHEWS asked permission to make a statement on behalf of Clark's College. On Mr. Clark recognising the deplorable negligence on the part of one or two officials, they were dealt with very promptly by being removed from their positions, and the two defendants were immediately discharged. The college at present had over 6,000 students, and naturally there was opportunity for irregularities to occur without the personal knowledge of the head of the college, who had to trust his subordinates. He desired to assure the public that there would be nothing lacking on the part of the college in future to see that no opportunities of the kind occurred again. With regard to the prospectuses, they would be at once corrected, so that no false impressions might be given, Mr. Clark being very insistent that nothing should be put in the prospectuses which was in the slightest degree misleading.

Mr. BODKIN believed the undertaking would be carried out in the thorough spirit in which it was given, but said that, should there be any failure—which he did not believe would occur—the Royal Society of Arts would have very carefully to consider whether Clark's College could remain a local centre for examinations in the future.

THE RUSSIAN TIMBER INDUSTRY.

The Russian Empire occupies the first place among the nations of the world in the extent of its timber resources, the value and quality of two-thirds of which are practically unknown. The total area of the Russian Empire is 8,647,657 square miles, or about one-seventh of the entire land area of the globe, and 39 per cent. of the surface of the Empire is under forests. Those in European Russia cover an area of 474,000,000 acres; Finland, 50,500,000; Poland, 6,700,000; Caucasus, 18,600,000; total, 549,800,000. In the Ural provinces forests cover 70 per cent. of the area; in the northern provinces 68 per cent., and in the four lake provinces 57 per cent. The Government owns 65 per cent. of these forests, possessing in European Russia, 285,598,941 acres; Caucasus, 12,826,387; Asiatic Russia, 360,519,435; Amur region, 288,742,000; total, 947,686,763. Twenty-three per cent. of the forests belong to the landed proprietors, and 9 per cent. to the peasantry. It is estimated that in western Siberia alone there are 465,000,000 acres in virgin forest, and eastern Siberia, although not quite so rich in timber, has sufficient forests for the world's supply of timber for years to come. According to the American Consul at Moscow, the largest timber districts in European Russia are in the north. The four Governments of Olonetz, Archangel, Vologda and Viatka, comprising a total area of 650,000 square miles, are almost entirely covered with timber, but the greater part has never been explored by civilised man, though expeditions are now being formed for the purpose of investigating the immense resources of the country. The State forests, during a recent year, yielded 1,286,560,000 cubic feet of lumber, the Department of Forestry realising in round numbers for the sale of timber, rent of lands, etc., £6,500,000. The expenditure, including £160,000 for cutting trees and sawing logs, amounted to £1,400,000, thus leaving a profit to the State of £5,100,000. It is stated officially that the reafforestation of State lands provides for more than the amount cut from the forests each year. The above figures do not include the timber lands owned by private parties in European Russia. They are divided as follows:—Imperial appanages, 14,274,500 acres; private landowners, 151,072,000; peasants, 29,210,000; joint-stock companies, factories, works, churches, etc., 6,853,500 acres. The Russian timber industry comprises 1,428 factories, saw-mills, planing establishments, wooden-box factories, piano factories, etc., the number of hands employed being 80,000, and the value of the annual output £16,000,000. This industry is one of the greatest in the Empire, and offers many possibilities, which should not be

neglected by manufacturers, of requisite machinery. In a recent year Russia imported saw-mill machinery and wood-working machinery to the value of £17,500 and £56,000 respectively. Timber ranks second in the exports of Russia, preceded only by grain.

THE MANUFACTURE OF POTATO-SPIRIT IN GERMANY.

The immense production of potato-alcohol in Germany is due largely to the agricultural advantage of the potato crop for rotation purposes, and the efforts of the Government to favour the business by the remission of taxes. Over 77 per cent. of the total production of German alcohol is obtained from potatoes, but only a comparatively small portion is sold in the form of beverages, for the reason that other kinds of alcohol are better adapted to the manufacture of liqueurs and brandies. The alcohols of wine, cider and cherries possess an agreeable aroma, whereas all alcohols produced from beets, grains, molasses and potatoes must be rectified before they are available for consumption, in order to free them of their unpleasant natural taste. As to potatoes, the resultant alcohol possesses an oily flavour, which would be particularly unpleasant if not eradicated by rectification. Potatoes intended for conversion into alcohol are first provided in the average proportion of 900 kilogrammes (1,984 lbs.) of raw material for the production of 26 gallons of 100-degree theoretical spirit. According to the American Consul at Hamburg, the potatoes are first washed, and then steam-cooked for the reduction of the starch to a state easily convertible into sugar. This steaming is commonly performed in a conical device, in which the tubers are boiled until soft. This soft material is next pressed through a grating provided with sharp edges, into the mashing-tub. As this first mashing is insufficient, the material is more completely disintegrated in the mashing-tub under a cylinder, or in a mill placed between the cooking machine and the mashing-tub. The malt is generally added in a crushed form, and further crushed into the potatoes. The fermented diastase in the malt converts the potato-starch into sugar in about thirty minutes, the most favourable temperature for this conversion being 130° F. Formerly a temperature of 150° F. was deemed necessary in order to destroy the schizomycetes inimical to the process of fermentation, but this destruction is now secured by adding fluoride of sodium, or fluor acid, in small quantities, to the ferment. The sugared mass is now cooled down by water and air, after which artificial yeast is added. This addition produces a fermentation in which the sugar is converted into alcohol in the wooden mash-tub. These tubs are made of oak or fir wood. As the manufacture of alcohol in Germany is taxed according to the space occupied for mashing purposes, the mash is made as thick as possible. At the present time there are about 6,000 small and 40 industrial distilleries in Germany. The crop of potatoes in Germany in 1909 amounted to 47 million tons, which was exceeded only by the crops of 1901 and 1905, 49 million tons and 48 million tons respectively, during the last eleven years. The production of alcohol from potatoes in Germany in 1908-09 amounted to 75 million gallons.

HOME INDUSTRIES.

Population in Scotland.—It is only natural that the figures of the Scottish Census have caused not only surprise but something not unlike alarm. The estimate of population to be found in the Statistical Abstract of the United Kingdom gives Scotland a population in 1911 of 4,929,251. According to the preliminary returns, the population given to Scotland by the Census is 4,759,521. Instead of an estimated increase of 400,000 in the decade, the actual increase is only 287,418. The gain in the decade represents an advance of 6·4 per cent., or a little more than one-half per cent. per annum. This is the lowest percentage, save one, recorded for more than a generation. Until the returns have been analysed the distribution of the increase cannot be precisely stated, but enough is known to make it safe to say that those from the rural districts are the most disappointing. In some rural districts there has been actual depopulation, while the urban figures—after all allowance is made for the alteration of town boundaries, and for the movement outwards so characteristic of every great town—do not show the increase that was expected. The explanation of this general decline in the percentage of increase, and actual decrease in some county districts, is not far to seek. The rural districts have suffered from the migration to the towns which has been going on for many years, and still more by emigration to other countries. In the last ten years there has been a great exodus from Scotland. In the United Kingdom we have now active Government official agencies for drawing population from our shores, which are becoming very efficient in suggesting to the working population that the United Kingdom is a poor place for lads of spirit. The Dominion Government is spending enormous sums in what may be called the literature of emigration, and the Commonwealth is beginning to follow suit. In these circumstances it is not strange that emigration grows apace, more especially when it is remembered that although the wealth of the United Kingdom has increased enormously during the past decade, the wages of workmen have not only not advanced but show a slight decline. The distribution of the increased wealth is extremely uneven, and never was the Biblical saying that "unto him who hath shall be given" better illustrated than in these days. So far as Scotland is concerned, the emigration is largely made up of peasants, of men we would fain keep in the country. But lamentable as it is, this emigration will almost certainly continue, and may well be accelerated, unless by some means or other the home prospects of the countryman are

improved. The magic of property, however small the holding, may suffice to keep him with us; it is doubtful whether anything less potent will do so. The facilities of travel, the spread of education, the emigration agencies, all tend to make the peasant, and in a lesser but still considerable degree the townsman, dissatisfied with his lot in the old country. Scotland has not reached the stage where population has become stagnant, but if the present tendency continues it may soon do so. As it is the population still grows, but year by year the countryside is becoming more depopulated. The big towns swell, but the land under cultivation shrinks. That is not a healthy state of things, and if no remedy is found for it the natural well-being must be greatly affected.

The Insurance Bill.—It may be said without much fear of contradiction that it would be difficult to name any Bill of first-class importance that has been received by the House of Commons with the general welcome and commendation extended to the State Insurance Bill. But without expressing any opinion upon the general merits of the Bill, it is to be feared that if it becomes an Act it will affect many persons in a way not contemplated or desired by its authors. Take, for example, that section of the Bill which deals with a very humble but numerous section of the community, the domestic servants. The proposal of the Bill is that each servant shall be required to affix three stamps to a card each week, and the employer another three. That gives the servant in case of sickness free doctoring and medicine, and an allowance of 7*s.* 6*d.* a week for the first three months and 5*s.* a week for the next three months. But, assuming that this is fair return for the money, and it is by no means certain that better terms might not be got from existing agencies, is there not a real danger that many employers will get rid of their servants rather than pay the 13*s.* per annum? It must be remembered that in an immense number of households it is a hard struggle to keep a servant, it is only possible to keep one to whom low wages are paid, and the additional 13*s.* may well turn the balance against keeping any at all. When the Workmen's Compensation Bill was before Parliament, and it was decided to include domestic servants, it was believed by the framers of the Bill that they were helping one of the most helpless of the classes. The contrary has happened. Although it is possible to insure against risk for a very small sum, two or three shillings, and this insurance relieves the assured of all responsibility and trouble, it has been found that in a large number of cases mistresses of the smaller sort—and they constitute the great majority of the households of the kingdom—have either dispensed with the charwoman and the general servant altogether, or refused to employ any person not in the prime of life. That has worked great hardship amongst women particularly requiring assistance. But now that these same mistresses are asked to pay a weekly sum which, to many of them, may mean a good deal, and also to be at the trouble of pasting stamps on every week, it is more than likely they will prefer to be without a servant, and once more an Act intended for their benefit will actually injure some of the more helpless of those it was intended to assist. That may be an inevitable consequence of any system of State insurance that the wit of man can devise, but whether or not, it is a difficulty to be considered. It may well be doubted, too, whether the proposals of the Bill as they affect the doctors who are to attend those to be benefited by the Act can be worked without grave injustice, and in some cases positive ruin, to medical men whose practice is practically confined to what are called the working-classes. Fortunately, there is no reason to suppose that the authors of the Bill will be unwilling to amend it upon cause shown. On the contrary, the Chancellor of the Exchequer has invited criticism, and promises to regard it with an open mind.

Malingering.—Among the less desirable consequences of the Bill, should it become law, malingering is likely to have a prominent place. And here, it is to be feared, the danger will not only be real but formidable. It is well known that the Workmen's Compensation Acts have greatly encouraged malingering. Men who in the days prior to these Acts met with accidents, sought to get well and to work again as quickly as possible, since anything like long illness meant calamity to the home. But the incentive to recovery will be greatly weakened if a man is to be able to rely upon 10*s.* a week for three months, and 5*s.* for another three months. These allowances, though modest enough in themselves, may be sufficient to lead to a serious spread of malingering. It may be that the Government will be able to devise some scheme of supervision which will prevent anything like serious imposition, but it is not easy to see how it is to be done. The Bill threatens something like a return to the state of things disclosed by the Poor Law Commission of 1834, and that is not a prospect that can be viewed with anything approaching equanimity. Every clause of the Bill calls for exhaustive discussion, but none more than the clauses which threaten to encourage the loafer.

Produce of Crops.—The Returns of Produce of Crops in Great Britain, just published by the Board of Agriculture and Fisheries, show that in the case of every crop the average yield for Great Britain was higher, and in some cases considerably higher, in 1901-10 than in 1891-1900. To England, considered separately, the same observation applies, and except for potatoes in Wales, and barley in Scotland, it would apply to those countries also. As Mr. Rew points out, increased yields per acre as between one period and another may be regarded as an indication of more favourable seasons, and as representing larger gross returns to the cultivators of the soil. They do not necessarily connote increased total production from

the land, unless the area cultivated remains at least equal in extent. The average annual production of wheat in Great Britain in 1901-10 was over half a million (547,042) quarters less than in 1891-1900, while that of barley was a million quarters less. The production of peas was 65,000 quarters less per annum, and of turnips and swedes more than a million tons less, while the output of hops fell from an average of 469,000 cwts. in 1891-1900 to 397,000 cwts. in 1901-10. On the other hand, the annual production of oats increased by 700,000 quarters, of beans by 154,000 quarters, of potatoes by 338,000 tons, of mangolds by $2\frac{1}{4}$ million tons, and of hay (of all kinds) by nearly a million tons. The home production of wheat has declined even more markedly in relation to demand than is indicated by the actual figures of diminished crops. In the first decade of the present century the gross production of wheat—which is, of course, not all brought into the market—in Great Britain was equal to 1·37 bushels per head of the population. In the preceding decade the gross production was equal to 1·66 bushels per head. For the six years ending with 1890—the official returns of crops do not go further back than 1884—the total wheat crop was equivalent to 2·26 bushels per head of the population at that time. The home supply of potatoes appears to have kept pace more nearly with the demand. The total hypothetical value of the corn crops in 1910—£31,550,000—was £4,600,000 less than in 1909, but a reduction, the extent of which cannot be estimated, must be made from the total value of the 1909 crops, on account of inferior and unmarketable corn. The value of the potato crop—£11,127,000—was £1,200,000 more in 1910, on account of the rise in prices, while the additional bulk of the hay crops was of an estimated value of £3,100,000. The total value of clover, etc., hay in 1910 was £13,710,000, as against £12,478,000 in 1909, and of meadow hay, £22,508,000, as compared with £20,643,000 in the preceding year.

CORRESPONDENCE.

IMPROVEMENTS IN THE TRANSPORT AND DISTRIBUTION OF GOODS IN LONDON.

I am sorry that I had to leave before the discussion on Mr. Gattie's paper on the 5th inst. concluded.

I venture to think Mr. Gattie has not covered the points I raised. Any modern improvements that save time and relieve congestion should be heartily welcomed, but, as I understand the matter, "The New Transport Company, Ltd." look to continuous working throughout the day as one of the essentials of their scheme, and it would seem that their figures need some modification.

It may be taken for granted that the bulk of orders coming by post arrive by the early morning deliveries. These orders are dealt with in the course of the day, and are ready towards evening for collection in order to be sent to various parts. Similarly, in the provinces orders executed during the day are put on rail for the evening trains to London, and arrive here in the early morning. After being dealt with by the Clearing House, it is not clear how these trains could immediately be reloaded, as the bulk of the outgoing traffic would not be ready until the late afternoon.

Every business house is desirous of receiving goods, if possible, by 9 a.m., and it would, therefore, appear that, although the provision for rapid handling in the Clearing House is on a fairly extensive scale, it would need still further extension to provide for this. If it requires five hours to dispose of the two hundred and ninety trains, it is obvious that quite a large proportion of the packages would not be delivered at their destination until lunch-time, and from the standpoint of congestion in the streets it is also desirable that all heavy wagons should be unloaded not later than 9 a.m.

With regard to documentation, Mr. Gattie does not clear up the point I raised. I quite agree that electric carriers can act—with human intelligence at each end—with greater accuracy than the "man with a truck," but I do not suppose even Mr. Gattie would claim that they can make out documents. The Hollerith tabulator, which does such marvellous work, does not read the invoices and punch the cards from which results are summarised.

The cases I have in mind are those where, after the documents are checked from a container, the goods are wheeled round, say, from the G.N. to the L.B. & S.C. Railway section of the building. In such cases a document can be handed to the man who wheels a truck, and he in turn can hand the same to the receiving man and obtain his initial in the book provided. The electric conveyor cannot do this, and as a large number of packages in transit would be going to small towns and villages, where present arrangements would have to continue, it would be necessary that the documentation should be in the usual form, and not, say, in the form of cards punched for electrical contacts which would be unintelligible at such places.

With regard to the distribution of goods, in order to accomplish rapid delivery in the early morning, and speedy collection in a limited time towards evening, I am inclined to think that the number of wagons mentioned by Mr. Gattie would have to be considerably augmented. He appears to be rather regarding the total volume of business on the assumption that he can keep a more or less even load throughout the day, which, for reasons given earlier, seems quite out of the question.

I hope that Mr. Gattie will see his way to explain clearly and fully how he proposes to get over the difficulties raised, as doubtless there are many others besides myself who found the explanation lacking in his paper.

S. CHAPMAN.

In reply to Mr. S. Chapman, reference to the working time-tables of the various railway companies shows that goods trains arrive in London in varying numbers all through the day and night. They are arranged to fit in with shunting requirements, and much valuable time is wasted as a consequence of this shunting. There are also hundreds of goods trains, plying between London's seventy-four goods stations, which would be rendered quite unnecessary under Clearing House conditions. But even under existing conditions Mr. Chapman's difficulties are hard to appreciate: e.g., the London and South-Eastern Railway have thirty goods trains coming into London between 8.20 p.m. and 2.40 a.m. By what black magic would the Clearing House be disabled from unloading and reloading those thirty trains?

What Mr. Chapman says, in effect, is this: "The Clearing House is all very well, but suppose a time-table got in the way?"

The question is reminiscent, and the answer to it is: "So much the worse for the time-table."

With regard to Mr. Chapman's question of documentation: On a labelled bale of goods being received at the Clearing House it would be removed from the container in which it arrived and checked off against the list of the contents of that container. It would be put on to a tray and sent to the necessary bay. On arriving at that bay it would be weighed, charged and entered, and put into the container provided to take it to its destination.

It is sufficiently obvious that any documentation possible in a goods station must be equally possible in a Clearing House, but, as indicated above, Clearing House documentation would be very simple. Each item, or group of items, would be booked *in*, and booked *out*, in exactly the same way as is practised in the Bankers' Clearing House.

Let us compare the simplicity of the Bankers' Clearing House method with that of the railway companies.

A case of goods weighing a little over one hundredweight was despatched from Tottenham to Bristol. It was collected at 12 a.m. on Thursday and taken to Tottenham Hale, thence to Bishopsgate, thence to Birmingham, thence to Derby, and thence to Bristol, where it arrived one week after the date of despatch. Here the consignee refused to accept delivery—a second consignment having been "expressed" by G.W.R. passenger train. Fifteen days after, the G.E.R. wrote to the consignor that the goods were lying at his risk at Derby, and demurrage would be charged. Another week elapsed, and after further correspondence the G.E.R. returned the goods to the consignor, made no charge whatever, and paid 15*s*. damages.

The advantage of the Clearing House system is, that it requires a coincidence of errors for a mistake to go through, and by its application to railway work such instances as the above would be much reduced in number.

A. W. Gattie.

NOTES ON BOOKS.

Old Clocks and Watches and their Makers. By F. J. Britten. Third Edition. London: B. T. Batsford. 15*s*. net.

In the third edition of his well-known work, Mr. Britten has added a considerable amount of fresh matter and over a hundred further illustrations, and the book is now a very complete historical and descriptive account of the different styles of clocks and watches of the past. Starting with a brief account of early time recorders—sundials, wick and lamp time-keepers, sand-glasses, etc.—the author passes on to weight-clocks, portable time-keepers, and pocket-watches. An interesting chapter is devoted to short sketches of the lives and achievements of the most famous makers, from Tompion, "the Father of English Horology," to the end of the eighteenth century. The next section deals with French clocks and cases, and this is followed by a chapter on English domestic clocks, including a very fully illustrated portion on "grandfathers." The last chapter includes a series of hall-marks, which is very useful as a guide in determining dates. An appendix contains the names and some biographical details of 11,000 former makers. It is interesting to note that thirteen of these received medals or other rewards from the Society of Arts, for various improvements in clocks and watches. The book is profusely illustrated throughout, and will still further enhance Mr. Britten's reputation as an authority on the subject of horology.

GENERAL NOTES.

Chinese Tea Exports.—The total quantity of tea exported from China in 1909 was 199,792,400 pounds, a decrease of over ten million pounds as compared with 1908. This reduction was due principally to a decreased demand for common black teas due, according to the American Consul at Shanghai, to the abundant supply from India and Ceylon of the low grades used in cheap mixtures. Steps are being taken to regain in some measure the trade in Ning-chow teas. The Viceroy and Governor of Kiangsi has been asked to supply the growers of these teas with fertilizers, as their decline is largely due to farmers having neglected to clean the ground, turn it over and fertilize it. In the Keeman district, where strict attention has been paid to these matters, the teas produced have attained great popularity, and the production, which amounted to 20,000 half-chests a few years ago, reached 95,000 half-chests in 1909. Owing to the absence of suitable storage facilities for the crop, especially that of the Hankow variety, which is stored in junks and subjected to all kinds of weather, etc., the Ministry has been petitioned to build a go-down capable of holding at least 200,000 half-chests of tea.

German Fresh-water Pearl Fisheries.—The once famous fresh-water pearl fisheries in the river known as the White Elster, in the Plauen district of Saxony, have steadily declined in importance. Although the fishing is carried on under the supervision of Government inspectors, and every care is taken to foster the growth of a variety of pearls well known on the market, the yield has so dwindled that during the past year only six good pearls and seventeen of second quality were found. This is a contrast to preceding years, when large quantities were obtained during the fishing season. From 1861 to 1900 nearly 4,600 pearls of all grades were found. Some of the best years were during the middle of the seventeenth century, but owing chiefly to the increase of factories along the banks of the stream, contaminating the water, as well as to the destructive agency of floods and ice-floes, the historic pearl fisheries are now threatened with extinction.

Commercial Schools in St. Petersburg.—There are in all twelve commercial schools in St. Petersburg, though none of these is strictly limited to commercial branches. General instruction is given to students from the age of nine to nineteen, and special instruction from sixteen to twenty-one. It is the special instruction only that contains commercial branches. For the two leading schools, for example, the curriculum in the special or commercial instruction is as follows:—Book-keeping and commercial correspondence, technical chemistry, political economy, jurisprudence, commercial law and law proceedings, history of commerce, commercial geography and statistics, commercial arithmetic, and the Russian, French, German and English languages. In the Imperial school the children of Russian merchants are admitted without pay. All other students, either Russian or foreign, pay £20 per annum if non-resident, and £45 if resident. In the Petrovski school all classes pay from £15 to £17 per annum, the lower scale being in the case of children of local merchants. An examination is required for admission to both schools, to be conducted in the Russian language. There are at least five other commercial schools in the city conducted by persons receiving authorisation to do so from the Minister of Public Works, where, in addition to the foregoing curriculum, the adult pupils, male and female, are taught stenography and typewriting.

International Congress of Applied Chemistry.—The Eighth International Congress of Applied Chemistry will be opened by the President of the United States, at Washington, on September 4th, 1912; the other meetings, business and scientific, will be held in New York from September 6th–13th. The Congress will be divided into twenty-three sections and sub-sections, including every branch of Applied Chemistry. Papers for presentation or publication should be in the hands of the American Committee on or before July 1st, 1912.

Uruguayan Ostrich Feathers.—The feather industry is of considerable importance in Uruguay, and the ostrich is one of the nation's valuable assets. The native ostrich or "nandu" of Uruguay and Argentina resembles the African bird in a general way, but is smaller, of a mixed grey colour, and has three toes, whereas the larger species has only two. A still smaller species is found in Patagonia, and seems to range much farther north, the males each having five or six females with them, generally keeping together in flocks of fifteen to thirty. These are found roaming throughout the open country of Uruguay. The average height is five feet, and the weight 80 to 100 lbs. each. Several females lay their eggs in one nest, which is merely a hole found anywhere in the ground. The eggs weigh about two pounds each, and are sat upon and hatched in forty days solely by the male. To secure the feathers, which have become an important article of export, the birds, at the time the plumage is full, are driven into previously-arranged nets and their feathers pulled out. The majority of the feathers are very fine, sometimes equalling, and even excelling, the African in quality, but smaller. This is remedied by joining three feathers lengthways. Some years ago there were nearly 100,000 native ostriches in Uruguay, but this number has recently fallen off, owing to the migration of the ostriches to Argentina.

The Production of New Zealand Flax.—Phormium tenax, or New Zealand flax, is indigenous to the country, and is found growing in low or swampy ground in all parts of the dominion. The plant grows from five to ten feet high, and it takes eight or nine tons of leaves to produce one ton of fibre. The method employed for cleaning and stripping the leaves is as follows:—The leaves are first put through the stripper to bruise the fibre and prepare it for washing, which is immediately done. This removes much of the woody matter. Then the material is spread on the grass to bleach, after which it is put through the scutcher, which cleans it and removes the coarse and broken parts called tow. The flax is then put into hanks and baled, when it becomes ready for market. A new machine has just come on the market, which automatically strips and washes the fibre in one operation.

Sericulture in the Province of Como.—A small quantity of selected "seed" (silkworms' eggs) has been placed, as an experiment, at the disposal of the Prefect of Como, for free distribution amongst the sericulturists of the province this season. The "seed," which is of three kinds, viz., Chinese and indigenous producing cocoons of yellow colour, and also a cross-bred variety, was obtained from the moths of silkworms reared last season on leaves that had been treated with a solution of chloride of silver. This solution is used as a remedy for the disease to the mulberry tree so prevalent in Italy.

MEETINGS OF THE SOCIETY.

ORDINARY MEETING.

Wednesday evening, at 8 o'clock :—

MAY 24.—FRANK M. ANDREWS, "Architecture in America." Sir ASTON WEBB, C.B., R.A., F.R.I.B.A., will preside.

INDIAN SECTION.

Thursday afternoon, at 4.30 o'clock :—

MAY 25.—W. R. H. MERK, C.S.I., LL.D., "The North-West Frontier Province of India." The Right Hon. the EARL OF MINTO, K.G., G.C.S.I., G.C.M.G., G.C.I.E., will preside.

CANTOR LECTURE.

Monday Evening, at 8 o'clock :—

ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., "Rock Crystal : its Structure and Uses." Four Lectures.

Syllabus.

LECTURE IV.—MAY 22.—*Scientific and Industrial Uses of Rock Crystal.* Its Thermal and Electric Properties, and its Transparency to Ultra-violet Rays—The Construction of Prisms and Lenses (including spectacles) of Rock Crystal, and their Advantages over Glass—The Use of Quartz for Balance Weights and in connection with the Interferometer—The Artistic Use of Quartz for the Carving of Vases and other Objects—Destruction of the Crystalline Structure by Fusion, and the Uses of Fused Silica in Fibres and Scientific Apparatus.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 22...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Dr. A. E. H. Tutton, "Rock Crystal : its Structure and Uses." (Lecture IV.)

Chemical Industries Exhibition, Agricultural Hall, Islington, N., 4.30 p.m. Mr. T. Tyrer, "Industrial Spirit." 8 p.m. Mr. L. Gaster, "Progress in Modern Illuminants and their Industrial Application."

Geographical, Burlington-gardens, W., 3 p.m. Anniversary Meeting.

British Architects, 9, Conduit-street, W., 8 p.m. Mr. R. Anning Bell, "Painted Relief."

Victoria Institute, 1, Adelphi-terrace House, W.C., 4.30 p.m. Rev. Canon J. A. MacCulloch, "The Descent into Hades : a Study in Comparative Theology."

TUESDAY, MAY 23...Faraday Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. 1. Dr. Arthur L. Day, "Recent Advances in Gas Thermometry." 2. Dr. J. A. Harker, "The High Temperature Equipment at the National Physical Laboratory." 3. Mr. H. C. Greenwood, "The Boiling-points of Metals." 4. Mr. A. Blackie, "The Behaviour of Silica at High Temperatures." 5. Communications will be read from Professor Bodenstein (Hanover) "On the Maintenance of Constant High Temperatures," and from M. Féry (Paris), on "Stellar Pyrometry."

Royal Institution, Albemarle-street, W., 3 p.m. Professor F. W. Mott, "The Brain and the Hand." (Lecture II.)

Chemical Industries Exhibition, Agricultural Hall, Islington, N., 8 p.m. Mr. R. W. Sindall, "Paper and Pulp."

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Dr. J. Stuart Thomson, "The Alcyonaria of the Cape of Good Hope and Natal." 2. Dr. H. W. Marett Tims and Mr. A. Hopewell Smith, "Tooth-Germs in a Kangaroo." 3. Dr. R. Broom, "On the Structure of the Skull in Cynodont Reptiles." 4. Rev. A. Miles Moss, "On the Sphingidæ of Peru." With a Preface by Dr. Karl Jordan.

WEDNESDAY, MAY 24...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Frank M. Andrews, "Architecture in America."

Geological, Burlington House, W., 8 p.m.

Chemical Industries Exhibition, Agricultural Hall, Islington, N., 8 p.m. Mr. C. Harrap, "Chemistry of Lithography."

Concrete Institute, 296, Vauxhall-bridge-road, S.W., 5.45 p.m. Mr. R. W. Vawdrey, "Reinforced-Concrete." (Lecture V.)

Mining and Metallurgy, at the Geological Society, Burlington House, W., 8 p.m.

THURSDAY, MAY 25...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Mr. W. R. H. Merk, "The North-West Province of India."

Antiquaries, Burlington House, W., 8.30 p.m.

Linnean, Burlington House, W., 3 p.m. Anniversary Meeting.

Chemical Industries Exhibition, Agricultural Hall, Islington, N., 8 p.m. Mr. W. J. Dibdin, "Sewage Disposal."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. N. Shaw, "Air and the Flying-Machine." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Dr. A. Abrahams, "High-Speed Photography."

FRIDAY, MAY 26...Municipal and County Engineers (Scottish District Meeting), Govan and Loch Arklet, 12 noon. 1. Discussion on Paper by Mr. F. G. Holmes, "The Main Drainage and other Municipal Works of Govan." 2. Discussion on Paper by Mr. W. C. Easton, "The Treatment of Govan Sewage." 3. Inspection of Burgh Works, etc.

Royal Institution, Albemarle-street W., 9 p.m. Professor Gilbert Murray, "The Greek Chorus as an Art Form."

Chemical Industries Exhibition, Agricultural Hall, Islington, N., 8 p.m. Mr. Noel Heaton, "Artificial Production of Precious Stones."

SATURDAY, MAY 27...Municipal and County Engineers (Metropolitan District Meeting), Town Hall, Wellington-street, Woolwich, 12 noon. 1. Mr. J. Rush Dixon, "Woolwich and some of its Works since 1905." 2. Mr. E. H. Tabor, "Description of the Woolwich Footway Tunnel under Thames." 3. Visits to Council Works, etc.

Chemical Industries Exhibition, Agricultural Hall, Islington, N., 8 p.m. Dr. F. M. Perkin, "Applications of Electro-Chemistry and Electro Metallurgy."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. P. Pycraft, "Phases of Bird Life : Migration." (Lecture II.)

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FRIDAY, MAY 26, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

CANTOR LECTURE.

On Monday Evening, May 22nd, Dr. ALFRED E. H. TUTTON, M.A., F.R.S., delivered the fourth and last lecture of his course on "Rock Crystal: its Structure and Uses."

On the motion of the Chairman, Sir WILLIAM H. WHITE, K.C.B., F.R.S., a vote of thanks was accorded to Dr. Tutton for his interesting course.

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

THURSDAY AFTERNOON, MAY 25TH, The Right Hon. The EARL OF MINTO, K.G., G.C.S.I., G.C.M.G., G.C.I.E., in the chair. A paper on "The North-West Frontier Province of India" was read by W. R. H. MERK, C.S.I., LL.D.

The paper and discussion will be published in a subsequent number of the *Journal.*

APPOINTMENT OF DELEGATES.

The Council have appointed their Chairman, Sir JOHN CAMERON LAMB, C.B., C.M.G., to represent the Society at the celebration of the Five Hundredth Anniversary of the Foundation of the University of St. Andrews, in September, 1911.

Sir BOVERTON REDWOOD, D.Sc., F.R.S.E., has been appointed to represent the Society at a joint meeting to be held under the auspices of the Society of Chemical Industry, for the purpose of securing a full attendance of British Chemists and a good supply of original papers at the Eighth Annual Congress of Applied Chemistry in Washington and New York in September, 1912.

CONVERSAZIONE.

The Society's Conversazione will be held, by permission of the Trustees of the British Museum, in the Galleries of the Natural History Museum, South Kensington, on Tuesday Evening, May 30th, from 9 p.m. to 12.

The Reception, by Sir JOHN CAMERON LAMB, C.B., C.M.G., Chairman, and the other Members of the Council, will be held in the Central Hall from 9 p.m. to 10.

A Selection of Music will be performed by the Band of H.M. Royal Artillery, in the Central Hall, commencing at 9 o'clock.

A Vocal and Instrumental Concert will be given in the Fish Gallery and a Miscellaneous Entertainment in the Shell Gallery, under the direction of Mr. PATRICK KIRWAN, commencing at 9.30 p.m.

The following portions of the Museum will be open:—

The Central Hall, containing cases of specimens illustrating Mimicry; Adaptation of Colour to surrounding conditions; Protective Resemblance; etc. Also specimens illustrating the Food of Fishes, and the Life History of the Eel (East of staircase).

The North Hall, containing the collection of Domesticated Animals.

The Bird Gallery, containing groups of British Birds and Nests; and in the Pavilion, at the West end, an exhibition of the Land and Fresh-water Vertebrate Animals of the British Isles.

The Fish Gallery, containing the Great Basking Shark, the grotesque Deep-sea Fishes (case 44), the Tunny (case 38), the Tarpon and Angler-fish (case 27), and the Lemon-Sole (case 30), etc.

The Shell Gallery, including a life-size model of a Giant Squid (Newfoundland), and of a Giant Octopus (California).

The East and West Corridors on the First Floor, containing the Okapi, African Antelopes, and Giraffes.

Light Refreshments will be supplied at Buffets in the North and South Corridors on the First Floor of the Museum, and at the end of the Bird Gallery.

Visitors travelling by the District Railway (or other underground railways in connection therewith) will be allowed free use of the company's subway, which leads from South Kensington Station direct into the grounds of the Museum.

Each member is entitled to a card for himself (which will not be transferable) and a card for a lady. (These cards have now been issued.) In addition to this, a limited number of Tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5*s.* each, if purchased before the day of the Conversazione. On that day the price will be raised to 7*s.* 6*d.*

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary at the Offices of the Society, John-street, Adelphi, W.C. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

The Council reserve the right of stopping the sale of tickets or of raising the price, if it is found necessary, in order to restrict the number of visitors within reasonable limits.

Further particulars as to the musical and other arrangements will be given in the Programmes, which will be distributed on the evening.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A Meeting of the Colonial Section was held on Tuesday, May 9th, 1911, His Grace the DUKE OF ARGYLL, K.T., G.C.M.G., G.C.V.O., in the chair.

The CHAIRMAN, in introducing the reader of the paper, said the bank with which Mr. Williams Taylor was connected was as well known as any bank in the district of the London Adelphi. Mr. Williams Taylor himself had had a very varied experience in Canada, throughout which he had proved his metal. He was bred in the maritime province of New Brunswick, but gained his great experience as a banker in Ontario, especially in connection with the lumber trade. Then, for a considerable space of time, he lived in Chicago (and all who knew that city would know what that meant in the way of hard work), and he had also spent many years in Quebec and Montreal. During the past three years there had been such a rush to Canada that a new world had developed in the West, and it was greatly owing to the assistance which the Bank of Montreal had extended to settlers in the way of advancing them capital that that vast new prairie country had been developed. So great had been the emigration from this country to Canada that many landlords had started abusing Canada for depopulating their country districts. He pleaded entirely guilty to the charge; he had always told every sturdy man he had met in the British Isles that if he had a little capital and energy he would do much better by emigrating to Canada. After all, the rush to Canada could not go on for ever, and he did not think there would be the slightest fear but that this country would receive back a goodly number of its people in very much better health and fettle.

The paper read was—

CANADA AND CANADIAN BANKING.

By F. WILLIAMS TAYLOR.

I trust those who have honoured me by their presence to-day have not been lured within the precincts of this hall in the expectation of being edified by a learned discourse of a technical and theoretical nature. If so, they are doomed to disappointment; and I therefore preface what I am about to say with my apologies for permitting the Royal Society of Arts to have used a too imposing and perhaps misleading title for my modest effort. My only claim to a knowledge of the subject before us is that in my residence of forty years in Canada—my birthplace—I spent twenty-five thereof in the service of that great banking institution which I now have the honour and privilege of representing in London, whilst as an inspector of the institution in question I visited and revisited every city and town of importance, and was thus afforded unequalled opportunities of acquiring information of every practical description.

It is not my intention, nor my inclination, to deal with the subject of banking in Canada technically and theoretically, but rather to present to those who are not conversant with the facts, or who have not visited our Dominion, or studied its banking equipment and system, a brief survey of the country—the natural resources thereof, the industries which have

followed in sequence, and the practical side of banking as applied to the financing of such industries, and providing financial accommodation generally in a new country where conditions necessarily differ greatly from those prevailing in this old centre of civilisation—followed by some general comments on our banking system and its salient features.

Before proceeding further, I may perhaps be permitted to interpolate that we have fewer banking theorists in Canada than in most countries, and, curiously enough, we manage to get along quite well without them. As a rule, Canadian bankers are too fully occupied in the practice of their profession to indulge in theorising. I remember one of our most successful bankers once expressed to me his satisfaction that he had no official in the employ of his institution who indulged in essays on the theory and practice of banking. The remark was called forth by an historic adjudication that the head of a certain bank—now defunct—who had been in the practice of emitting serial discourses on banking management, had been sequestrated from his fellow-citizens for a term of years in the provincial penitentiary for malfeasance of office.

Thirty-four years ago Canada was constitutionally a vast disjointed territory stretching from the Atlantic to the Pacific, and from the international boundary line north, to a land of which it has been said "the mountains are nameless, and the rivers all run God knows where." Under the ever-memorable administration of Sir John Macdonald, the process of political integration known as Confederation was inaugurated in 1867, and presently the whole country became welded into the Dominion of Canada.

In addition to British Columbia, which comprises the spacious area between the Rockies and the Pacific Ocean, Canada has been divided by Nature into two countries, an East and a West, separated by Lake Superior and Georgian Bay, water areas bigger than Scotland, and by a stretch of wild rough country north thereof some six hundred miles in width, largely uncultivable and therefore ill-adapted for settlement. It is true that north of the Height of Land—say, roughly, one hundred miles north of the great bodies of water referred to, and south of James' or Hudson's Bay—there is well-timbered territory and land more or less suitable for agricultural purposes, but it is highly improbable that this district can or will support more than an exceedingly sparse population for many years to come. The far-seeing fathers of Confederation recognised the potential wealth of our Western prairie country, and the vital necessity of linking it to British Columbia on the Pacific Coast, and to the eastern provinces—hence the Government support accorded the construction of the Canadian Pacific Railway, the creation of which railway was one of the conditions upon which British Columbia entered Confederation.

I may interject that for the reasons given the natural channel of trade between the western portion of Canada and the United States of America is north and south, but our good cousins to the south of the forty-ninth degree of latitude shook off their allegiance to Great Britain in 1776, and there has since come into being north of that latitude a nation which, in order to preserve its political entity, develop its resources, and keep flying Britain's Imperial flag, has been compelled at vast expense to create highways in defiance of Nature, and thereby to divert the flow of trade eastward and westward. That Canada has been successful in carrying out what thirty-four years ago was by many considered a mad policy, is a matter of history. We can all recall the time when the Canadian Pacific Railway was the subject of heated discussion in and out of the Dominion Parliament, some doubting if it ever would be completed, or even kept open if it were, whereas to-day its securities vie in popularity with the best in this or any land, and it is admittedly one of the greatest creations of modern days, with ramifications undreamed of at its inception, and with a future which the least sanguine would hesitate to limit. Nor is this all, for presently the Grand Trunk Pacific and Canadian Northern Railways will become trans-continental lines.

Now it will be obvious even to those who have not visited Canada, that a country some 3,500 miles in width, and extending from the international boundary line to the North Pole, must have a variety of climates, of physical features, and of natural resources; and in order that I may make clear to the uninitiated the nature and scope of a banking system which provides for the financial requirements of such a great territory, I purpose, with your permission, approaching my subject province by province.

The Provinces.

We speak in Canada of the Maritime Provinces, consisting of Nova Scotia, New Brunswick and Prince Edward Island; of Quebec; of Ontario; of the North-West, comprising the

Provinces of Manitoba, Alberta and Saskatchewan; and of British Columbia and the Yukon.

PRINCE EDWARD ISLAND.

Prince Edward Island, the smallest of the maritime group, our baby province, was originally discovered by one of the Cabots in 1497 or 1498. Jacques Cartier, who followed in 1534, is said to have described it as "low-lying, without harbours, the most beautiful land it is possible to see," and indeed it is a peaceful, beautiful spot, where poverty is unknown and all are "content with their lot, contented and happy with what they have got." It changed hands continually in its early history, until finally ceded to Great Britain by the French in 1763. It has an area of about 2,200 square miles, or, say, 1,400,000 acres, of which over nine-tenths are cultivated; hence the designation sometimes given to it of the "million-acre farm." The surface of the island is gently undulating, and eminently pastoral and agricultural. At one time it was densely covered with beech, fir and other trees, but though still well wooded, the forests have, from a commercial point of view, disappeared. There are no minerals of importance, and the principal industries are agriculture and fishing, with a limited amount of manufacturing, as compared with other parts of Canada. The island is well populated for its size, the inhabitants numbering 103,000, mainly of English, Scotch, and Irish extraction, with about 14,000 French-Canadians. Those who have not eaten Prince Edward Island oysters have something to live for! The banking requirements are not extensive, being mainly to traders, wholesale and retail houses, and in connection with the fisheries. There have been several local banks in the history of the province, but all have been absorbed or otherwise ceased to exist, branch banks having taken their place.

NOVA SCOTIA.

The Nova Scotia peninsula was the most important portion of the old French province of Acadia. Its authentic history dates from 1604, when the fortified town of Port Royal—the oldest in North America next to St. Augustine in Florida—was established by the French. Within the next one hundred and six years Port Royal was successively captured by the English, restored to France, surrendered to the English, ceded to France, and finally captured by the English in 1710. In 1749 Halifax was founded, and a civil government established there to replace the military government of Port Royal. In 1755, owing to the persistent refusal on the part of the Acadians to take the oath of allegiance to England, they were removed. Hence Longfellow's highly inaccurate but charming "Evangeline." Visitors will have no difficulty in finding her home—"the little village of Grand Pré," where "still stands the forest primeval, the murmuring pines and the hemlocks." Between 1776 and 1783 over thirty thousand loyalists poured into the province from the rebellious States to the south, and about the same time there was a large Scottish immigration. The present population of the province is about 475,000, and is almost entirely of Anglo-Saxon descent, with perhaps 10 per cent. of French-Canadians. Halifax, the principal city, has a population of 55,000. Its harbour, which never freezes over, is one of the best, not only on the North-American coast, but in the world.

In size Nova Scotia is, roughly, 350 miles by 100 miles at its greatest length and breadth. Cape Breton, separated from the mainland by the Gut of Canso, has an extreme length and breadth of 100 miles by 85 miles. The total area of both is about 21,000 square miles. It was in Cape Breton that the famous fortification Louisburg was erected by the French Government early in the eighteenth century, at a cost of some £3,000,000, and captured by the English in 1758.

The topographical feature of Nova Scotia is an undulating surface, with beautiful fertile valleys lying between low mountain ranges seven hundred to a thousand feet in height, while the country resembles closely in general appearance the north of England and Scotland; hence its name. Few northern countries contain greater inherent wealth and variety of natural resources. The most important of these is agriculture, with dairying, fruit-growing, mining, fishing and lumbering. The coal-mines, situated on the seaboard, are practically inexhaustible, as are the fisheries, which—like those of Newfoundland—have been operated for several centuries. At one time Nova Scotia had immense quantities of standing timber, and the province was famous for its wooden ships. Much of the timber has disappeared, although there are still large and valuable areas of small spruce. One of the most important industries of the province is the manufacture of iron and steel, the plant of the Dominion Steel Company at Sydney being one of the largest in Canada. Otherwise, manufacturing

is on a very moderate scale as compared with the provinces of Quebec and Ontario. The Annapolis Valley is famous for its fruit—indeed, its apples cannot be surpassed, and the industry is of great importance.

A feature of Nova Scotia and New Brunswick is that both are most thickly settled along the coasts, owing to the fact that the early settlers hesitated to venture into the interior, partially through fear of Indians, and partially because the coast waters and inlets teemed with fish, giving a ready supply of food, in addition to providing a natural means of communication in days when roads were non-existent. It followed in consequence that the inhabitants took to fishing and lumbering—both offering a quick return for their labours—to the neglect of agriculture, and even to-day nothing like full advantage is being taken of the agricultural possibilities of Nova Scotia. This applies still more to New Brunswick, a large portion of the interior of which province is dense forest, visited mainly by lumbermen and fishermen, and hunters in pursuit of the famous moose.

New Brunswick.

New Brunswick is 230 miles by 190 miles in extent at its greatest length and breadth, with an area of 28,000 square miles. It was originally a part of Acadia, then of Nova Scotia till 1784. Apart from the earliest settlers—the French, whose descendants now number some 85,000—the population of about 250,000 is of pure British stock, many—as in Nova Scotia and Ontario—the descendants of those loyalists who left comfort and prosperity behind them in the United States, and came north in 1776 to what was then considered the end of the world, simply and solely out of loyalty to the British flag. Topographically, New Brunswick is much more broken, with many more mountain ranges, than Nova Scotia. The chief industries are lumbering and fishing. There are cotton, fish-canning and other factories, but otherwise manufacturing is on a smaller scale even than in Nova Scotia. In the valley of the St. John River, and elsewhere, there are agricultural areas with land of the finest quality. The principal city, St. John, founded by loyalists, with a population of 57,000, has an excellent harbour on the Bay of Fundy.

From lack of local opportunity many of the young men of the Maritime Provinces have sought their fortunes in other parts of the Dominion or abroad, and full credence is given to the statement that the Lower or Maritime Provinces have turned out more men of note in proportion to their population than any other part of the Dominion. This is not due to a fish diet, but to the excellent quality of the original stock, coupled with an educational system which has been good for many years. Until the last five years there has been little immigration for a century into the Maritime Provinces, the tide running more strongly towards the west, but a fair proportion of immigrants are now going in, and the number should and will increase.

Two of our most successful banks are of Maritime Province inception — namely, the Royal Bank of Canada (formerly the Merchants' Bank of Halifax) and the Bank of Nova Scotia. Nor must the Bank of New Brunswick be overlooked, an institution which came into being in 1830, and although of modest size, with few branches, has a record of which it may well be proud. Several Maritime Province banks have come and gone.

In the cities of Halifax and St. John the banking accommodation is somewhat similar in character to that required, say, in places of similar size in this country, but in the small towns—most of which are along the coast—banks are called upon to finance small traders who often combine shopkeeping with fishing and lumbering operations. Advances are made that fluctuate in amount throughout the year, but seldom run off, as the loans for different purposes overlap each other. This is not an attractive form of loan business, as the banker's capital is thereby tied up, making him somewhat of a permanent silent partner, but it is a class of accommodation that has always been demanded by the requirements of the community, was encouraged in the past by local banks, and which it is now difficult to avoid. There is little poverty in the Maritime Provinces, nor is there great accumulated wealth. No figures are published showing the proportion of bank deposits in the separate provinces of Canada, but *per capita* they are certainly less in the provinces in question than in Quebec and Ontario.

These provinces are traversed by the Intercolonial and Prince Edward Island Railways, both Federal Government roads, the former with termini in Halifax and Montreal. In road-bed and equipment, the Intercolonial will compare favourably with railways in England. With the aid of an American charter, the Canadian Pacific Railway cuts across the State of Maine from Quebec to St. John—its Atlantic

winter port for freight—and it has also running rights over the Intercolonial to Halifax. The former Company has recently acquired the Dominion Atlantic Railway, running from the Bay of Fundy, through the Annapolis Valley to Halifax. There are other railways, which time will not permit me even to mention.

Quebec.

Quebec, the next province in geographical sequence, has an area of about 350,000 square miles. Roughly, the province is about 1,000 miles east and west by 300 north and south—or, say, about three and a half times as large as England and Wales. The population is about 2,000,000, of which some 1,300,000 are French-Canadians. I should like to say regarding the latter that the process of transforming Frenchmen into Anglo-Saxons is a slow one—it took a good many hundreds of years to accomplish this end in England—but there is no room for doubt, not only about the devotion of the French in Canada to their country, but that they have a keen appreciation of the advantages of British rule, which has left them in full enjoyment of their civil and religious liberties. On the other hand, all broad-minded British-Canadians look upon their French fellow-countrymen as one of the country's valuable assets. Few countries, if any, have had such a respectable class of immigrants as the French who came to Canada in the eighteenth century. It is true that they are, with rare exceptions, seldom conspicuous in great commercial and financial undertakings, and as farmers are unprogressive; but in striking contrast they have given us many of our most brilliant statesmen and politicians, including Sir Wilfrid Laurier himself, of whom Canadians of every political and religious creed are proud, while in the legal profession they are prominent, and in the labour market invaluable.

In the country districts the "habitants" retain all the charm of their Normandy and Brittany ancestors — a simple, hard-working, healthy, thrifty people. "On the long winter evenings the men still sit before the blazing maple-log greasing their 'bottes sauvages,' while the wooden 'sabots' of the women click gaily on the snow-white pine floor, or their felt slippers thud gently to the hum of the spinning-wheel." Truly we English-Canadians have been singularly indifferent to the picturesque side of our fellow-countrymen.

The surface of this province is varied with innumerable rivers, lakes, streams, forests, lofty hills and mountain ranges. Jacques Cartier discovered the St. Lawrence in 1535, and in 1608 Champlain founded the City of Quebec, "that stronghold of New France, now the antiquarian gem of Canada, where first fluttered from the stately glacis the lilies of France on their azure field, where the best blood of France held sway in citadel, chateau and seigneury." What a roll-call of illustrious dead must haunt that grand rock high above the mighty river. Surely there is nothing in North America to equal it in historical and picturesque interest.

The capture of Quebec by Wolfe in 1759 was an event in English history, the importance of which time accentuates.

It is estimated that some 116,000 square miles of the province are covered with merchantable timber; the main portion of the remaining lands is well adapted for agriculture, the soil being rich and loamy. The natural resources include timber, minerals, fisheries, etc., while its unsurpassed water-powers are of the utmost value for manufacturing and lighting purposes.

At various periods in the history of Quebec we have had French-Canadian banks of some importance, but these have not been so successful as their Anglo-Canadian competitors, and only three now remain, namely, La Banque d'Hochelaga, La Banque Provinciale du Canada, and La Banque Nationale—all of good standing. In the matter of manufacturing, the province of Quebec comes second to Ontario. Montreal, with a population of 500,000, is the commercial, financial, railway and manufacturing centre of the Dominion, and is situated at the head of sea navigation.

The Bank of Montreal was organised in 1817, the Quebec Bank in 1818, and the other existing banks which originated in the Province of Quebec are the Merchants' Bank of Canada, Molsons' Bank, the Union Bank of Canada, and the Eastern Townships Bank.

Ontario.

Ontario—formerly called Upper Canada—was partially explored by Champlain in 1615, but French settlements did not follow as in Quebec, the warlike Iroquois Indians holding sway over the province for many years; therefore, the founders of the province may be said to have been the loyalists who emigrated from the United States after the American War of Independence. The province of Ontario has been called the "backbone of Canada," and the expression is not inapt, situated as it is midway

between the east and the west, and occupied by a prosperous community, with an unadulterated population of between two and three millions of people overwhelmingly of British extraction, devoted adherents of Anglo-Saxon laws, religion and traditions. The area is 260,862 miles, of which 40,354 miles are water, and approximately one-half the whole province is still covered with timber. The surface generally is an undulating plateau, without great elevations. The province is rich in minerals, timber and agricultural lands, and the lake fisheries are of great value. The timber resources of Ontario consist principally of pine and spruce of unexcelled quality, of which the annual cut is about 600,000,000 feet, valued approximately at 9,000,000 dollars.

Its mineral resources include the famous cobalt mines, the output for the province being valued in 1909 at 32,700,000 dollars.

Fruit is produced in great quantities—the Niagara Peninsula in particular being famous for its apples, pears, peaches, grapes, etc., which grow to perfection. The province is the greatest manufacturing district in Canada, with industries of every description and almost limitless water-power, so that it is, in fact, a self-supporting community. The province has a network of railways, the total mileage aggregating 8,400; also great waterways, extensive canals, and splendid inland shipping facilities.

Toronto, the capital of the province, has a population of over 300,000—about the size of Dublin—and is admirably situated for lake navigation. It is the next most important manufacturing centre to Montreal, and is a well-kept, well-governed city, with as imposing buildings and as fine parks as any city of its size in the Empire.

Ottawa, the capital of the Dominion, next in size, with a population of 90,000, is beautifully situated on the Rivers Ottawa and Rideau, and forms with its Parliament buildings a picture which we Canadians regard with what we hope is pardonable pride. With boundless water-power at its door, it too has become an important manufacturing centre, particularly in those industries allied to the lumber trade. The splendid rivers referred to extend far into the north, into valleys famous for their white pine, which is thereby all made tributary by Nature to the city.

Hamilton, with a population of 75,000, is also a busy and growing hive of industry. Other important manufacturing points are Brantford and Peterborough, while London, with a population of 50,000, is an important distributing centre of the Niagara Peninsula. There are innumerable other towns of varying importance, each with industries in very many cases operated by water-power, all—with rare exceptions—active and progressive, not overlooking Fort William and Port Arthur, strategically situated at the head of inland navigation. The climate is very similar to that of the Eastern Provinces, but with a more open winter along the St. Lawrence, the Great Lakes, and the Niagara Peninsula.

Fur-bearing animals and game abound in the northern portions of the Province.

The banking requirements of a territory with such varied resources and industries are naturally unlimited, and the best evidence thereof is that no less than twelve of our existing twenty-nine banks originated in and have their head-quarters in Ontario, among them the Canadian Bank of Commerce, the second in size and importance of all our banks.

NORTH-WEST PROVINCES.

The North-West Provinces, comprising Manitoba, Alberta, and Saskatchewan, formerly called "Rupert's Land," extend from a short distance west of the head of Lake Superior into the Rocky Mountains, say about a thousand miles in width and extending from the American frontier into the frozen north. They have a combined area of about 2,500,000 square miles. The geological formation of the north-west differs from that of any other part of the Dominion, the whole territory having at one time been a great inland sea, which accounts for the richness of the soil, probably the most fertile in North America. Prior to 1811 the territory had no written history beyond the brief records of the Hudson's Bay Company. In 1670 a monopolistic charter was granted by Charles the Second to "the Governor and Company of Merchant Adventurers trading into Hudson's Bay"—by usage abbreviated to the "Hudson's Bay Company"—to so vast and unknown a territory that it could not be specifically defined, but as the actual wording was "the bays, rivers, lakes within the entrance to Hudson 'Streights,' together with all the lands, countries and territories upon the coasts and confines thereof," the Company legitimately exercised administration over the whole territory from Lake Superior to the Rockies and north to the Polar regions. Not only so, but their tenacious hold enabled them subsequently to secure grants westward to the Pacific coast, including what is now British Columbia. At

that time the only inhabitants were Indians and Hudson's Bay Company traders. In 1811 Lord Selkirk obtained from the Hudson's Bay Company a grant of 116,000 square miles, conditional upon the establishment by him of a colony and upon supplying the Company with men. The headquarters of his settlement were near the present site of Winnipeg, and, by the way, I have been told that wheat has been grown continuously, without fertilisation, on land in the Selkirk—or Red River—Valley ever since. In 1836 the Hudson's Bay Company repurchased for £84,000 the 116,000 miles previously granted to Lord Selkirk. In 1867 the Canadian Government claimed the whole Hudson's Bay Company's territory by right, but by agreement gave the Company £300,000 in cash, with a right to one-twentieth of all lands surveyed for settlement within fifty years, accompanied by certain guarantees against undue taxation. The main portion of the whole region in question is rolling prairie country, admirably adapted for agricultural purposes, and particularly for wheat; in fact, it has become the most famous wheat area in the world, as regards both quality and extent. Obviously, therefore, agriculture is the all-important industry; though there are great areas of coal of fair quality, and a small amount of standing spruce, cedar and tamarack in the most eastern and northern districts. The North-West Provinces have 7,600 miles of railway.

Winnipeg is the great distributing centre of the West, and its growth is one of the wonders of the day. In 1870 the population was 215; in 1901, 42,000; while to-day it is estimated at 152,000. The population of the whole north-west has likewise increased by leaps and bounds, namely, from 43,000 in 1871 to (estimated) 1,100,000 in 1911. An idea of the development of the north-west may be gathered from the fact that in 1870 there was not a chartered bank in the whole district. To-day there are 592 branches of various banks. The population is somewhat mixed, as a result of immigration from the whole world, but the great majority are of Anglo-Saxon origin, and the sentiment—thank Providence and good government—is British to the core, and we believe will always so remain.

The banking accommodation required is almost entirely to the grain trade, to wholesale and retail traders and to farmers and cattle breeders. There is one local bank, formed in 1905, the Northern Crown, with its head office in Winnipeg.

British Columbia.

British Columbia, the Maritime Province of the Pacific, extends from the summit of the Rockies to the Pacific Ocean, and is, roughly, 700 miles by 400 miles in size. Its southern boundary is the United States of America, running north to the sixtieth parallel of latitude. Its area is about 385,000 square miles, of which less than 100,000 miles is said to be cultivated or capable of cultivation. In addition to the Rockies there are three other mountain ranges, with valleys between, more or less suitable for agriculture, the Okanagan Valley notably so.

Sir Francis Drake is supposed to have sighted Vancouver Island in 1578; in 1592 the Spanish explorer Juan de Fuca gave his name to the Straits, and explored the waters between Vancouver Island and the mainland. In 1778 Captain Cook, under instructions of the British Government, explored the coast. In 1792 he was followed by Captain Vancouver. It is a fair statement of fact that the credit belongs to the Hudson's Bay Company of keeping the British flag flying in the early days of this territory, for the Government of the day took no interest in the matter. In 1867 British Columbia entered Confederation, the primary stipulation being that it was to be connected by rail with the Eastern Provinces; hence, as previously stated, the Canadian Pacific Railway. The climate is salubrious on the coast, corresponding closely with that of the south-west of England, and has proved attractive to all, but particularly to English people. The population, estimated at 200,000, is essentially Anglo-Saxon, and British in sentiment. The most important natural resources are minerals, lumber, and fisheries, all of immense value. There are also rich agricultural and fruit areas, the latter unsurpassed—in fact Nature has been prodigal, as British Columbia contains the greatest areas of merchantable timber in North America, coal which seems in inexhaustible quantities, unsurpassed fisheries, a wonderful climate, free from extremes of heat and cold, a commanding seaboard position, and some of the grandest scenery in the world. A large proportion of the province is a sea of mountains, many parts thereof rich in minerals, most of it unfit for cultivation, but all picturesque to a high degree. The cultivable areas are extremely fertile, and admirably adapted to fruit growing and mixed farming. There is only a limited amount of manufacturing, apart from lumber. Salmon-canning is an important industry. In natural resources there is a great similarity between British Columbia

and the Maritime Provinces. The growth of Vancouver, the principal city, has been extraordinary; less than forty years ago it was an unbroken forest; in 1901 it had a population of 27,000; to-day it has 100,000 at least. The banking requirements are mainly in connection with the financing of the products of the forest, the field, the mines and the fisheries, and the wholesale houses and retail dealers. The Bank of British Columbia, incorporated in 1862, an institution of importance and of excellent standing, was absorbed in 1900 by the Canadian Bank of Commerce. Its shares were largely held in this country. A small local bank called the Bank of Vancouver has recently been established.

Résumé.

Now those who have had the patience to follow me so far will be better able to form an idea of the nature of the banking facilities required by a country so vast that it is equal to an aggregation of countries. There are different climates, different resources, and some mixture of nationalities, and various provincial governments, but only one flag, and the entire country is united in its respect for Anglo-Saxon laws and institutions, and in devotion to this Mother Country. The whole territory is served, and admirably served, by twenty-nine banks with about two thousand five hundred branches, the combined paid-up capital and reserve being about £38,000,000.

Early Banking.

But I must retrace my steps, and first touch lightly upon the early history of banking in the Dominion.

Prior to the capture of Quebec by Wolfe in 1759 there is no record of any form of banking, and there was probably little need for banking institutions, though the Intendant Bigot indulged in forms of high finance coupled with unadulterated corruption which have not been equalled in modern days—not in Canada, at any rate—and which resulted in 1763 in a sentence which offers certain points which I confess I do not regard with disfavour. As Dr. Doughty, the historian, relates, the finding of the courts against this eighteenth-century financier was as follows:—"In reparation, the said Francis Bigot is condemned to make the *amende honorable* before the principal gate of the Tuileries, whither he shall be escorted by the public executioner in a tumbril, having a rope about his neck, and bearing in his hand a lighted torch of yellow wax two pounds in weight. On his chest and on his back shall be placed a placard with the inscription—'The Public Administrator, Perfidious Thief,' and then kneeling bare-headed and with bare feet, clad only in his shirt, he shall declare in a loud and intelligible voice that during his administration of New France, in peace and in war, he has been guilty of the frauds, extortions and thefts set forth in the indictment." Incidentally, he was condemned to execution, which was, however, commuted to confiscation of his ill-gotten wealth and banishment from the realm. Who shall say after this that Louis Quinze had not a sense of justice?

In 1792 the Canadian Banking Company was organised by certain English merchants, but its existence was brief, and beyond the fact that it exercised the function of note issue it left about as little record behind as "the canoe which crossed the bosom of some lonely lake a thousand years ago."

The retirement by the British Government of their Army bills issued to meet the expenses of the war of 1812 with the United States, marked another stage in the course of events, and led to the establishment in 1817 of the Bank of Montreal. From lack of formal legislative authority this bank started business under articles of association, though the charter was not granted by the Quebec Legislature until 1821, nor the Royal assent secured until 1822. The Quebec Bank came into being in 1818, the Bank of New Brunswick in 1820, the Bank of Nova Scotia in 1832, others following in due course. Further charters were granted about the same time, but the institutions securing them have come and gone. Those, however, just mentioned, remain and have prospered, and it may be said that the records of the Bank of Montreal in particular embrace the financial history of Canada. In the period between 1829 and 1866 Breckenridge tells us that not a single chartered bank went down in failure. Since that date a good many have appeared and disappeared, but the same remark is, of course, applicable to England and to other countries. The first general Bank Act was passed in 1871, four years after Confederation, unifying the rights and privileges of each as their pre-existing charters expired later on. Under this Act the various charters were extended to 1881. Since then charters have been regranted decennially, and revision also takes place every ten years.

You will doubtless all agree that it will serve no useful purpose on an occasion such as the present to recite further in detail the numerous

alterations, additions, restrictions, failures and successes which go to make up our banking history. To the student and banker the subject contains much of interest and a good deal that is edifying, and to such I would recommend Breckenridge's "History of Banking in Canada"—a carefully-prepared work containing an accurate recital of the facts. A more recent outside but friendly criticism—also American—of our system, by Mr. Joseph French Johnson, Dean of the New York University School of Commerce, will also be found interesting and instructive, particularly as it comes from a citizen of that great and wonderful nation occupying the other half of the North-American Continent, the banking system of which differs so essentially from our own. I shall therefore proceed to deal with our system as at this date, referring briefly to some of its distinctive features, and the application of the whole to the financial affairs of the Dominion.

Canadian Banking System.

In Canada, as in all countries, the banking system is the result of a slow process of evolution, but I think I may be permitted to state that we started right—thanks to those hard-headed Scots, who were not only conspicuous in the promotion of our earliest banking institutions, but in commerce and in the administration of the affairs of the country. Naturally they and their English and Irish cousins embodied in their articles of association, and in their rules, regulations, and general practice, the fundamental principles of the institutions of the Mother Country, gradually deleting features inapplicable, and modifying and creating, in accordance with the different financial and trade conditions, the greater area of operations, and the needs of the community, until a point has been attained where we can—without egotism—say that we have a system, not perfect, it is true, but admirably adapted to the requirements of the Dominion, probably as much so as the banking system of any other country.

Now, it is the case that the aim on the part of the bankers of Canada thus to adapt themselves to the requirements of the people—with the wise co-operation of the Government, between whom there has continuously been the closest sympathy—has not only accrued to the advantage of the banks, but has been a factor in the development of the country, its trade, its commerce, its transportation facilities, its resources, its financial stability, and in natural sequence in our national credit, particularly in London, the importance of which is beyond computation. Johnson says Canada's system "was not created by lawyers or statesmen to meet the fiscal needs of the Government, but has grown up gradually under the fostering care of experienced bankers, no changes having been made until experience proved them necessary or advisable," and I agree, but may truly add that the system would never have been brought up to its present pitch of excellence had not our Premiers and our Ministers of Finance had entire confidence in those bankers.

Not in any spirit of unfriendliness I venture to assert, regarding the United States of America, that if they had had a banking system and enjoyed currency laws corresponding with Canada's, it would have made an infinite difference, and the world would not stand bewildered and amazed at the financial crises which periodically convulse that great and rich country—and, *per contra*, nothing more clearly illustrates the richness of the United States and the virility of its people than that, in spite of defective banking and currency laws, the country has made and is making so marvellous a progress that it fills the universe with profound awe.

Our Canadian system is in effect a unifying and co-operative one. The bank, acting as a medium, receives deposits from the prosperous farmers in agricultural districts, where there is little demand for borrowed capital, lending it throughout the length and breadth of the land, where it is required by the business requirements of merchants, manufacturers, miners, millers, and financial houses. The branch banking system which affords us this facility, enables us to pay depositors a rate of interest with which not only are they well satisfied, but which enables the banks to advance to the said merchants, manufacturers, etc., at a more uniform and moderate rate than would otherwise be the case. The rate of interest on what we call savings accounts is 3 per cent. throughout the whole Dominion, and the rate of interest charged on loans varies little—the difference being not more than, say, 2 per cent. between the rate paid by the trader in some remote Atlantic fishing village, the rich merchant or manufacturer in the commercial centres, the lumberman, the miner, even the farmer in the north-west, or the tradesman in British Columbia. Banks may stipulate for, take, reserve or exact any rate of interest or discount not exceeding 7 per cent. per annum.

Again, without any intention of making invidious comparison with rates in the United

States, I may say that entirely opposite conditions exist across the line. In some of the western states, for instance, 9, 10 and 12 per cent. is paid by borrowers who would not be called upon to pay for similar accommodation more than, say, 6 per cent. in Canada. It is true the banks in such districts pay a much higher rate of interest on deposits than with us, but the margin between the loan and deposit rates is greater in that portion of the United States, and the heavy charge for loans is a serious disadvantage to the community.

Formation of a Bank.

The Bank Act of Canada aims at protecting the public against the creation of weak or improperly-managed banking institutions, and with this object in view in the first place prohibits the use of the name "Bank" except under Government charter. In the formation of a bank the procedure is then as follows:—Respectable men of substance who are required to become important shareholders must agree to act as provisional directors, and are obliged to secure from the Parliamentary Committee on Banking and Finance a favourable report upon their project. The Committee proceeds to satisfy itself that the enterprise is *bonâ fide* not only in its inception but in its aims. Should the full capital—which cannot be less than 500,000 dollars — be subscribed, and 250,000 dollars thereof paid up within one year, a meeting of shareholders may be called and the permanent directors elected, the latter applying in due course to the Treasury Board for permission to issue notes and commence business, the authority being granted only if the requirements of the law have been fully satisfied.

Currency.

In the early days of Canada the Hudson's Bay Company emitted to an extent, and from a date unrecorded, a form of paper money, but until the middle of the eighteenth century it is doubtless the case that the principal money of the country consisted of beaver, moose and other skins, and probably brandy, developing gradually into "card money," issued without restraint in the closing decades of New France, followed by British Army bills, and finally by the banknote system of to-day.

The present currency system of Canada is essentially elastic, automatically expanding and contracting according to the demands of trade and variations of the seasons. All banks may issue notes of the denominations of five dollars or multiples thereof, to the extent of their paid-up capital, free of tax or specific security, such notes being a prior lien against the assets of a bank, and also against a liability on the part of the shareholders up to twice the amount of the subscribed capital. In addition, note-holders are further protected by what is called the Circulation Redemption Fund — under which each bank is compelled by law to deposit with the Government 5 per cent. of its average circulation, this fund constituting a common insurance. There have unfortunately been failures of several of the smaller banks since this provision became law in 1890, but not once has the fund been resorted to. The result is absolute confidence in bank-notes as a medium of exchange. Along with silver and copper coins, they constitute almost the sole circulating medium; in fact, there are parts of Canada where a gold piece is looked upon with a certain amount of curiosity, almost amounting to suspicion. No one thinks of carrying gold for pocket-money. The Dominion Government issue notes in denominations of one, two and four dollars, and of fifty dollars and upwards. In 1908 there was outstanding 68,000,000 dollars thereof, of which the main portion was in denominations of 500 dollars upwards, which are entirely held by the banks in their reserves. Dominion Government notes are secured by not less than 15 per cent. of those outstanding in gold; notes in excess of 30,000,000 dollars must by law be secured by an equal amount of gold.

Banks may issue notes in excess of their capital during the usual season for moving the crops, viz., from October 1st to January 31st following, to an extent not exceeding 15 per cent. of their combined unimpaired paid-up capital and reserve. On such excess, interest at the rate of 5 per cent. per annum must be paid to the Government.

Call Loans and Reserves.

Some of the leading Canadian banks loan largely on call and to the Stock Exchange in London and in New York at the rates of interest of course prevailing in those markets, which rates are usually naturally much lower than for call money or for commercial business in Canada. In actual practice such Canadian banks earn little more, and may in fact earn less, as a rule, on such loans than they pay on deposits in Canada for the main portion thereof, which seems like bad banking, but the object is obvious, namely, to keep their reserves employed even at a small rate of interest, rather than have the whole amount lying idle in their vaults in the shape of bullion.

As a safeguard against financial exigencies, the policy of the Bank of Montreal for many years has been not to lend on call in Canada, but in London and New York, where money can be taken off the market without disturbance for its own requirements, or for the strengthening of the Canadian position, should necessity arise. This policy, though disadvantageous in the matter of interest, is sound not only as applied to the institution itself, but to Canada as a whole—in fact, a sheet-anchor of recognised importance.

Dividends.

From the bankers' point of view, the margin in the rate of interest paid on deposit and received on loans in Canada is satisfactory as compared with this country, and you might therefore wonder why bank dividends in Canada are not as high as in England and Scotland. The explanation is that in Canada banks have far less free money—that is, deposits not bearing interest—than in Great Britain, and the second reason lies in the fact that in Canada, as in all new countries, banks suffer more numerous losses than in an old civilised centre such as this, where the permanence of business establishments makes for more stable conditions.

Warehouse Receipts.

One of the conspicuous features and wisest provisions of the Canadian Bank Act, and one which has enabled banks to an incalculable extent to assist in the development of the trade of the country, is that relating to warehouse receipts. In a new country such as Canada capital is scarce, but opportunity, energy and ability plentiful. Now for a bank to advance the money at its disposal on the security of the personal qualities mentioned would be obviously unsound banking, but under the terms of Sections 84-90, inclusive, of the Bank Act, a bank may lend not only to individuals on the security of goods, wares or merchandise against hypothecation of warehouse receipts and bills of lading, representing such goods in the custody of a third person, but they may advance in this manner to the actual possessor of the goods on his own receipt, such receipts vesting prior inalienable rights in the bank from the date of the acquisition thereof; in other words, the banker acquires a direct unregistered lien upon the securities represented by the receipts as against all other creditors. The beneficial result of this law is that a bank with confidence in the probity, ability and energy of a customer, readily advances with reasonable margin to an extent which would never be entertained otherwise, and a borrower is thereby enabled to carry on a business largely in excess of that which would be possible under other circumstances, at the same enjoying all the advantages of having his goods in his own possession instead of in the custody of a warehouseman. Johnson states that this form of security makes our banks silent partners in our wholesale and manufacturing businesses, and I suppose this is one way of looking at it, with this all-important qualification, that the bank of course embarks its money against a maximum profit represented by interest of only, say, 5 or 6 per cent. per annum.

It may interest you to have illustrated the method by which the banker advances to, say, a lumber firm, under the Act relating to warehouse receipts. Let us take the case of a firm of lumbermen with a capital of, say, £200,000 invested in saw-mills costing £40,000, and timber limits £120,000, the balance being represented by book accounts, bills receivable, and manufactured lumber. As the winter approaches the firm applies to their banker for a loan of, say, £60,000 for forest operations, to be availed of over a period of about five months. Concurrent with each advance the banker takes from the firm a formal undertaking to furnish security on the logs and lumber to be created. First the lumberman buys and sends into the forest-shanties supplies for the lumbermen or shantymen, and for the horses; also plant, including bob-sleighs, saws, axes, chains, ropes, etc., required in the operations. In Eastern Canada this would be attended to in November. The shantymen arrive in due course, and proceed to build their shanties, made of logs. By this time the snow is on the ground, which suits their purpose, and they proceed to fell the trees, which are cut into lengths, skidded, i.e., piled in heaps, to be removed by teamsters on bob-sleighs along snow roads sprinkled with water, which, freezing hard, gives them solidity, to the nearest ice-covered river or lake. This process continues during the whole winter, until perhaps towards the end of March, the firm receiving further advances from time to time from the banker. Then with the thawing of the ice this stage of the operations ceases; some of the men are paid off, while the remainder drive the logs down the rivers—one hundred or two hundred miles, as the case may be—to where the mills are situated. There the logs arrive probably in June, when the "undertaking" referred to is supplemented by a security receipt, as it is

called, similar in character to a warehouse receipt. The process of converting the logs into lumber starts forthwith, and usually continues during the whole summer months. Towards the end of the summer the green lumber is ready for the market, and in due course is converted into cash or bills, and the banker repaid; but only by gradual process, as almost invariably one season's operations overlap another, viz., the banker is called upon for fresh advances before the previous ones are liquidated.

Another illustration would be the financing of the great cereal crop of the West. The grain dealer borrows from the bank on his personal receipt to pay the farmer; presently, when the grain is moved east, the railway bill of lading takes the place of the receipt. The bill of lading is later exchanged for an elevator receipt, which in due course is exchanged for ocean bill of lading, which accompanies the draft drawn on the firms abroad to whom the grain is sold, and from the proceeds of which draft the banker is reimbursed.

I have only given you two illustrations out of many, from shipbuilding to egg-packing. A very large part of the commercial banking business of Canada is carried on on such lines, but its scope cannot be better described than by reciting Clause 3, Section 88 of the Bank Act:—

"The bank may lend money to any person engaged in business as a wholesale manufacturer of any goods, wares and merchandise, upon the security of the goods, wares and merchandise manufactured by him, or procured for such manufacture."

It is probably as sound commercial banking business as can be found in most countries. There are occasions when the most gilt-edged securities cannot be realised readily, whereas the necessities of life can be marketed under any conditions. The banker must be careful, intelligent, and not too trusting. It is difficult for him, often impossible, to know—even by observation—whether the goods he has been advancing against actually exist to the extent hypothecated, and a borrower who sets out to defraud his banker can usually do so; that is the weak point. Should the borrower come to grief, the bank can, after a formal demand for payment, step in and take possession of the goods, realising them to the extent necessary to recoup itself. There is no registration of warehouse receipts, and a warehouse receipt cannot be taken to secure a pre-existing debt.

Bank Inspection.

Our system of bank inspection corresponds in general principles with that prevailing in this country, and is highly satisfactory if the duty be efficiently performed. The inspector or inspectors with their assistants visit each branch, unannounced, at least once a year, taking possession, for the time being, of the cash, securities and books. Balances are struck, and each item in the balance-sheet proved, and a written report upon each loan account, expressing the inspector's views regarding its condition and safety, forwarded to head office. This check, following upon the daily audit of the business maintained by the chief officers of the branch, leaves little room for clerical mistakes. The inspector's report, when it reaches head office, is studied by the superintendent of branches, and then placed before the general manager and the board. Bank inspectors in Canada must be men of exceptional intelligence, for they are required to visit branches thousands of miles removed from the head office, and in many cases theirs is the only independent opinion, other than the branch manager's, available for the chief executive officers regarding the business generally and the loan accounts. If the inspector is wise, he visits timber limits, factories, mills, mines, the fisheries, the warehouses, or the ranches of all important borrowers, so that he can form some idea of the practical working of the business which his bank is financing. If the inspector has superior intelligence, and his bank has branches extending from ocean to ocean, he should acquire an unequalled knowledge of his country, for it is obvious that he must travel ten to twenty, or even thirty thousand miles a year, in visiting the respective branches, and in doing so, meet at the hotels, clubs and private houses, and in the railway carriages and steamers, practically all the men of importance in every walk of life, and in every section of the community.

Customers' Balance-sheets.

An interesting contrast between the custom prevailing in this country and in Canada in dealing with commercial customers is that in the Dominion it is a *sine quâ non* that borrowers furnish their bankers with detailed information regarding their affairs, supplemented by a balance-sheet, copies of profit and loss accounts, etc., at least once a year. As my banking friends who are present are aware, a request for such data in England would in many cases be looked upon as semi-insulting. It is true that in old commercial centres such as this, trade is conducted upon more established lines, and I do not presume to criticise, but content myself

with stating that in Canada the practice is advantageous to bankers and customers alike—the latter finding in the former, as a result of his confidence, a guide, counsellor and friend. Divided bank accounts are rare in consequence.

Real Estate.

One of the wise provisions of the Canadian Bank Act is that banks are not permitted to lend on real estate, or upon the security of real estate mortgages. A bank may acquire real estate for its own use, or may hold and dispose of realty to secure a pre-existing debt, or may purchase under execution, etc., real estate of a debtor, but not otherwise, nor shall any bank, having acquired property in the method above indicated, hold it for more than seven years—*vide* Section 3 of the Bank Act. There has been at various periods in Canada's history, and there is now, much speculation in real estate, which would increase if the banks had the legal right to finance such operations.

Bank Failures.

We have bank failures in Canada, but they have not resulted from defects in our system, but from the lack of ability or the dishonesty of individuals, against which contingency completely effective safeguards are difficult to secure. Almost invariably it has been incompetence coupled with misadventure which has led to disaster. When collapse comes, it is usually found that false returns have been made to the Government, probably for a period of years. This experience is, of course, found in all countries — I have seen it stated that the accounts of the City of Glasgow Bank were falsified for five years prior to its failure. In Canada, swift justice is dealt out to the criminal—one general manager is only now completing a sentence of several years imprisonment, and another was sentenced to seven years within the last few months for making false returns to the Government. Altogether there have been nine Bank failures in twenty-two years, but they were all in the second or third rank as regards standing and size, and in no case have the note-holders suffered loss, while depositors have lost little.

Trained Bankers.

In Canada, as in this country, general managers and managers of banks are trained bankers, having invariably been engaged in their profession since their early youth. In the United States the opposite is frequently—in fact, usually—the case. I have known important executive heads of large American banking institutions who have spent the main portion of their lives in the profession of medicine or law, or in commercial pursuits.

General Managers.

In Canada the general manager is from circumstances somewhat of an autocrat—the Board of Directors rarely having among their number men with the time or banking training which would enable them to follow in detail the course of a bank's business. The Chairman or President does not, as in this country, devote his whole time to the conduct of the affairs of his bank, nor are there Executive Committees. The system has its advantages and disadvantages. Autocracy is a simple, safe, and effective form of government or administration, provided the autocrat is fully qualified for his great responsibility. In Canada we have been singularly fortunate in this respect.

Conclusion.

Assuming that I have convinced those present of the important part Canadian banks have played in the upbuilding of the Dominion, I should like to add that no section of the community appreciates more keenly the vital necessity of an uninterrupted flow of capital. American capital will be forthcoming, as in the past, for the development of private enterprise, and English money for such purposes will doubtless follow in ever-increasing volume, but the Federal Government, the Provincial Governments, the Municipalities and the great transportation companies, must be financed in London, and that is one reason why the safeguarding of the national credit of Canada in this —the greatest of all money markets—has been, is to-day, and will continue to be, one of the most important accepted duties and responsibilities of Canadian banks, and it also explains why wise Canadian bankers with branches in London have so persistently declined to stand sponsors to doubtful public emissions.

In the words of wisdom of Mr. R. B. Angus, who has had fifty-four years' banking experience in the Bank of Montreal, of which he is President:—

"Contributions through the Stock Exchanges and money markets of Europe to the financial enterprises of Canada have been extremely generous of late, and it is eminently desirable that the confidence thus displayed should not be abused. Some offerings have been made, it is feared, by over-sanguine promoters whose statements it would be hard to justify, and in relation to schemes where

the advantages to buyers are not quite apparent. It might be well to consider that, while money seeking investment is much more abundant in some countries than it is with us, there is seldom much lack of capital in Canada for participation in enterprises that are unquestionably sound. Our European friends might reflect that a home market, especially in the case of industrial securities, will generally furnish some indication of values."

In conclusion, may I, as a Canadian who has had the advantage of residing in the United States, and of knowing that country from end to end, who has enjoyed the inestimable privilege of living in this parent country, refer to the sub-conscious fear haunting every Englishman and pleasing dream of every American, that some day Canada will become part of the United States?

As one with an enormous acquaintance in Canada, and who has visited and re-visited every city, town and section of the community, I tell you with pride, my Lord Duke, my Lords, ladies and gentlemen, that I do not know one single Canadian who believes in such an eventuality, who harbours a thought so disloyal to our traditions, so contrary to our ambitions. Our earnest desire is to live on friendly terms with the United States, and to settle by arbitration any possible disputes that may arise, but our determination is to retain our political entity, and our anthem is now, and shall be in the ages to come, as it was in 1776, "God save the King!"

[Maps were kindly lent for the occasion by the European Traffic Manager, Grand Trunk Railway System, and by the General Passenger Manager, Allan Line Steamship Company, Limited.]

DISCUSSION.

The CHAIRMAN remarked that Mr. Williams Taylor had told a story of immense progress in banking business, founded, as he said, upon Scottish caution. His was a delightful tale of the conservatism, in its best sense, of Canadian banking. He thought one feature which illustrated the caution of the manager of the Bank of Montreal was that, although he had touched on every part of Canada, he had hardly mentioned the Porcupine district, where the discoveries of gold had lately excited the population of Ontario. He had been told that no one would look at silver there at the present time, thinking only of gold, although a few months ago he had received a solid brick of silver from that region, which was equal to anything that had ever been found in the States. Mr. Williams Taylor, however, had only mentioned the North Ontario mines in an incidental and passing manner, and had laid all stress on the banking system and the recent developments in east and west.

Lord STRATHCONA expressed his appreciation of Mr. Williams Taylor's paper. As a director of one of the principal banks of Canada for the last forty years, he knew something of the practical working of Canadian banks. He might mention, as confirming Mr. Williams Taylor's comparison of the banking system of Canada with that of the United States, that one of the ablest of the Secretaries of State of the United States had told him it would have saved America a great deal of financial trouble on several occasions if the Canadian system of banking had been adopted by the United States banks. He thought the Society was under a very great obligation to Mr. Williams Taylor for the care and consideration he had given to the subject.

Sir FELIX SCHUSTER said Mr. Williams Taylor had given such a glowing picture of the opportunities which Canadian bankers enjoyed that London bankers could not but look upon them with admiration, and with a certain amount of envy. He had rightly laid great stress on the commercial development of Canada, and emphasised the fact that commerce, itself based on agriculture, was the foundation of all banking. Where the opportunities of trade did not exist, banking could not be prosperous. On the other hand, banking to a great extent assisted the development of trade, and in that connection Canadian banks had been of the greatest service in developing the commerce of the country. Mr. Williams Taylor, in the first part of his paper, deprecated somewhat the theorist in banking, but, he (Sir Felix) thought, had disproved his own argument at the conclusion of the paper, which showed that he himself understood the theory of banking very thoroughly, and that the Bank of Montreal and other Canadian banks had worked on a sound banking doctrine. It was only by following that sound banking doctrine that they had been so prosperous. Canadian banks carried on their operations under a Bank Act, and practical bankers had no doubt been consulted in respect to that Act, who, if they had not mastered the banking theory to some extent, would not have been able to have drafted so successful a statute as the Bank Act of Canada had proved. He would like to ask Mr. Williams Taylor whether banknotes in Canada were legal tender all through the country. Could one bank pay their own banknotes by the notes of another bank, or had they to be redeemed in gold? The same question also applied to the notes issued by the Government. He had been much struck with the provisions laid down by the Canadian Bank Act, which regulated the securities on which a Canadian bank could make an advance. Such a system did not operate in any way in this country, where every bank regulated its own transactions according to what it thought was a

prudent and wise course. In Canada a bank could only lend on certain securities. He should like to ask whether the bank could advance money without security?

Mr. WILLIAMS TAYLOR replied in the affirmative.

Sir FELIX SCHUSTER (continuing) thought such a state of affairs was extremely curious; a banker could lend to a man without security, but could not lend on real estate. He thought the provision whereby a Canadian bank could not lend on real estate was an eminently wise one, and had no doubt saved the banks, and the country at large, from an excess of speculation in land, which was so often seen in other countries where rapid developments took place. On the whole, Mr. Williams Taylor was quite justified in being proud of the banking system of his country. He (Sir Felix) was sure that the Canadian bankers recognised their duty, and he did not believe that any unsound scheme would come from them to this country. A great responsibility rested on Canadian bankers, but he thought they were fully alive to it. In conclusion, he congratulated Mr. Williams Taylor on the wonderful progress of the Montreal Bank, and also on the marvellous development which all industries were making in Canada.

The Right Hon. Sir CHARLES TUPPER said, as a Canadian, he felt deeply indebted to Mr. Williams Taylor for his graphic statement of the past and present of Canada. He had been reminded by the paper of what had occurred some years ago at a time of great depression and stagnation of trade in the United States of America, when one of the most eminent men in that country drew the attention of the people to the fact that, while in the United States millions of people were suffering and 300 banking institutions had failed, in Canada not a single bank had failed, and the only way in which Canada seemed to be affected was by their contiguity to countries which were suffering as the United States were. He believed Mr. Williams Taylor's paper had, to a large extent, illustrated the cause of that, namely, that Canada had a better system of banking than the United States. It had been a great pleasure to him to notice the presence of his Grace the Duke of Argyll, under whom he had had the honour of serving as a Minister in Canada for several years. He should not be doing Canada justice if he did not say that among all the distinguished men who had represented the Sovereign in Canada, no one had discharged his duty more to the satisfaction of the Canadian people than his Grace. From the moment he first placed his foot in Canada, down to the present time, his Grace had never lost an opportunity of advancing the interests of Canada. As an illustration of the wonderful change which had taken place in that country, he might mention that in 1880, as Minister of Railways and Canals, he was pressing the construction of a line of railway from the Atlantic to the Pacific. Mr. Blake, one of the ablest and most distinguished men that the Liberal Party ever had at its head, and who then occupied the position of Leader of the Opposition, moved a resolution to prevent the railway from proceeding any further than the eastern side of the Rocky Mountains; and he might also mention that so distinguished a man as Sir Wilfrid Laurier voted for that resolution. On a subsequent occasion, in 1884, when the Canadian Pacific Railway Company were obstructed in obtaining means, either in this country or in the United States, for the development of their line, he was called upon to go to Canada to deal with the subject, and when he proposed that Canada should go the rescue, by a loan of thirty million dollars, Mr. Blake remarked: "Do not call it a loan; you know we shall never see a dollar of that money back." Nevertheless, the money was repaid within four years with interest, and he had lived to see the 100-dollar stock of that railway appreciate to 240. That was an illustration of the enormous progress Canada had made. As one of the men who had been engaged in laying the foundations deep and strong of the federation of Canada, which united the separate and scattered provinces under one, thereby preventing them falling like ripe plums into the adjoining Republic, he might say that one of the great objects which his colleagues and himself had in view was to hand down to their children's children, for all time, the great blessing of British institutions. He had no hesitation in saying that great as were their expectations at that time, they had been enormously surpassed by what had occurred. On the occasion when he had been called upon to open the Mechanics' Institute, in St. John's, New Brunswick, fifty-one years ago, he expressed the hope that he might live to see British North America united from sea to sea under one government, and presided over by a Prince of the blood. If he was spared a few months more, he would see that hope realised by the Government of Canada being handed over to H.R.H. the Duke of Connaught. Canada would expect a great deal from that distinguished gentleman, because she had enjoyed the inestimable pleasure, not only of being presided over by his Grace the Duke of Argyll, but by the Princess Louise, who won all hearts and led every Canadian to look forward with the greatest pride and pleasure to the continuance of Canada under the Government of the British Empire.

Lord BRASSEY, as an ardent well-wisher to Canada, said he had the greatest pleasure in moving a vote of thanks to Mr. Williams Taylor for his paper. It had been delightful to follow the glowing descriptions given by Mr. Williams Taylor and to fill up the picture with the intimate knowledge of an eye-witness. Canada was a country of magnificent resources, and it was fortunate for her that her banking system had been conducted under the rules, and in the sympathetic spirit, which had been described. The Bank of Montreal had been

singularly fortunate in including among those who had the custody of its interests Mr. Williams Taylor.

The Hon. J. L. GRIFFITHS (Consul-General of the United States), in seconding the vote of thanks, said the only cheerful thing he had discovered in the banking laws of Canada was the fact that bankers could loan without security. Notwithstanding all that had been said about the differences in the banking laws of the United States and Canada, it was reassuring to hear from Mr. Williams Taylor that there were two or three Canadian bank managers who were in solitary confinement at the present moment studying the provisions of the Canadian bank laws, which they, through oversight, had violated. It had been his pleasure some years ago to meet Mr. Williams Taylor. He then discovered that Mr. Williams Taylor was a typical banker. He had that air of aloofness which he (the speaker) had always found in approaching a banker. When he persuaded Mr. Williams Taylor that he did not want a loan on questionable security, he found him to be one of the most congenial of men. Mr. Williams Taylor's description of the progress of Canada had sounded more like a fairy tale than a record of actual happenings. He (the speaker) felt that the prosperity of Canada was due, not so much to the men who had come after, as to the early pioneers, the men who had endured sacrifices, and many of whom had experienced martyrdom to make Canada what it is to-day. He had been very much touched by the general expression of opinion that there was not the slightest possibility of the annexation of Canada by the United States. Such a thought had never been entertained in America, and as he had listened to what had been accomplished in Canada, he began to feel a slight apprehension that there might be sinister possibilities, deeply concealed in the minds of some Canadian statesmen, to annex his country, and he wished to enter his protest against any such project! He felt it was a great joy that the relations between the United States and Great Britain are as satisfactory as they are.

The vote of thanks was then put and carried.

Mr. WILLIAMS TAYLOR in reply, said he thanked the speakers for their very kind and complimentary remarks, quite as much as if they had been fully deserved. The presence of the Duke of Argyll further proved, if any proof were needed, his Grace's sustained interest in Canada, which had been such an intense gratification to the people of the Dominion. Many years had passed since his Grace had reigned at Rideau Hall, but time merely accentuated the affection and regard which he and Her Royal Highness the Princess Louise had won from Canadians under the Chairman's ever memorable and gracious administration. He also wished particularly to thank that great banking authority, Sir Felix Schuster, for the very kindly criticisms he had made, his fellow-province man, Sir Charles Tupper, and his friend, Mr. Griffiths, from the country beyond the Line, the virility and power of which had always filled him with profound awe.

TWENTY-SECOND ORDINARY MEETING.

Wednesday, May 24th, 1911; Sir ASTON WEBB, C.V.O., C.B., R.A., F.R.I.B.A., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Lambert, Thomas Stoddart, J.P., 7, Arlington-street, Wellington, New Zealand.

MacAllister, Edward B., Rockland, Maine, U.S.A.

Pan Wi Yan, 39, Heeren-street, Malacca, Straits Settlements.

The following candidates were balloted for and duly elected members of the Society:—

Côté, Thomas, International Waterways Commission (Canadian Section), Ottawa, Canada.

Fourie, Petrus Jacobus, Jansenville, Cape Colony, Union of South Africa.

Mott, Howard Schenck, 100, Broadway, New York City, U.S.A.

Piesse, Mrs. Adelaide E., Mountain Ash, Addlestone, Surrey.

The paper read was—

AMERICAN ARCHITECTURE.

By FRANK M. ANDREWS.

The art of architecture in any country finds a twofold source from the architectural tradition and the moral and intellectual character, political organisation, and mode of life of its people. To trace intelligently its development and artistic worth, these broad conditions must be accounted for.

Unlike the sister arts of painting, music, and sculpture, it cannot be detached from the masses, for it is not a creature of the museums or of the private collector, nor of the exclusive patronage of the favoured intellectual few, isolated as a thing apart, to be sought out and found in order to be felt and understood.

Contrary to these, it is the serviceable and intimate art of man, insistently a part of his familiar daily routine, a creature of his needs and circumstances, arousing in even the most heedless a consciousness of its existence and its power of expression either of beauty or of ugliness. For this reason, architecture artlessly

becomes an inevitable exponent of the characteristics of the people it serves, and the unerring index of their time and epoch.

The wisdom of the Greek philosopher was the intellectual flower of the human race, belonging to all mankind, but the architecture of Greece expressed the genius of the Greek alone, indicating the antecedents, environment, and soil which nourished and made possible the Greek philosopher. The Gothic cathedral, the feudal castle, the walled town, the monastery, and the vanished hovel of the common people told the story of mediæval times, of the great religious movement and the feudal system of the Dark Ages, with its cloistered learning, its strong arm of military and exclusive political might, and the subserviency of the masses. Again, the readjustment of these conditions, the resulting dissemination of learning, and the establishment of political and religious freedom, are faithfully reflected by the architectural development that kept pace with it throughout Europe.

In this brief allusion to a period momentous in its importance to the development and uplifting of the human race, I am touching upon matters entirely familiar to yourselves, yet which I wish to emphasise in order that you may appreciate that a discussion of American architecture must necessarily be approached with a similar regard for its political and civic development.

What I have to present to you deals with, perhaps, one hundred years of antecedent history, and does not exceed four decades of a subsequent movement that possesses any degree of architectural significance to others than ourselves. Yet as unerringly as in Europe we have recorded, in the terms of our art, the forward movement of our people.

Our land, colonised from England, Spain, France, and Holland, drawing to itself a population from most of the peoples of the globe—a land stretching from ocean to ocean, having climatic conditions ranging from those of Norway to those of Northern Africa—with its mineral, agricultural, and other natural resources sketched in with a broad and lavish hand, was in its inception and early history notable for its isolation. This isolation was not only geographical, but is reflected in a political system that is intensely and jealously individualistic, the keystone of its fabric being personal freedom and independence. As a new star in the firmament of government, it was peculiarly jealous of its own orbit, and largely justified its being by its very indifference to all European influence, fearing that therein lay discord and entanglements dangerous to the common welfare. Clearly the fundamental concept of this new government was the abandonment of the established European order of things, with its habits, customs, traditions, and conclusions, in so far as human determination could effect it. Pomp and display, class distinction and the exaltation by rank or otherwise of an individual or group, which in Europe played so important a *rôle* in the development of its civilisation, were not to find place in this new scheme of things, and, as a natural corollary to it, almost the entire vocabulary of architectural thought was automatically abandoned.

Therefore we find in early times but a trace of the interesting and inherent architectural beginnings such as were characteristic of Egypt, Greece, Rome, and the various European nations, nor do we find a place for a receptive disposition towards those architectural types which at that time prevailed throughout Europe, as its expression of the power and importance of government or of a class.

A timid concession to traditions, which could not be altogether denied, we find reasonably applied to the first structure of the national capital and in the executive mansion at Washington. These structures owed their existence and excellence to the interest of Washington, Jefferson and Hamilton, the locating of the capital itself giving to our most important architectural effort of the time a personal significance, corresponding to their influence in the affairs of our Government. Throughout the Colonial period we find in New England and in Virginia, with its sister States, a faithful adherence to the manners and customs of the Mother Country, its architecture consequently that of the coincident Georgian period of England, and the word for it in our architectural vernacular, "Colonial." With us an architecture of brick and wood, severe, simple, and with a certain refined stateliness, owing its existence as a precedent to the influence of our then leaders of thought and action, and merely reflecting their point of view, it ultimately became only a mode or habit of construction without architectural force or vitality. Its earliest and best examples, preserved by a fortuitous circumstance throughout a century of neglect and indifference, became in the end a helpful educational influence pointing towards the true path of artistic excellence; a cudgel with which to belabour a heedless utilitarian public but too prone to an inartistic

display of its swiftly-acquired wealth, and to awaken its artistic conscience.

Again we rediscovered the rare beauty, quiet strength, and world of suggestion in the old Spanish missions of southern California and the south-west. Glowing with artistic spirit, in their extreme isolation from the then civilised world, they seem a miracle of accomplishment. They are the product of minds who loved art, and remembered it as of the land of their birth; but, forced by environment and conditions to a fortunate simplicity, they preserved and created for the admiration of our future generations the essence of all that is good in the architecture of Spain. To-day this work is a powerful source of inspiration to the prosperous people of all that region of the United States where these good old mission fathers did their work of civilisation, leaving behind them evidence of their love of the beautiful. These then were the slender links that united us with the ancient architectural forms, and while they were not inherent nor endowed with a spontaneous expression of ourselves, nor an indication of our future development, they for the moment served as a borrowed garment, fortunately a good one.

The story of our departure from these standards, and the subsequent period of artistic squalor and ignorance, which I may refer to as our architectural Dark Ages, was one, however, not of wilful ignorance nor purposeful neglect, but of a condition.

It is the story of these people isolated by a great ocean, and by the greater intellectual ocean of abandonment of European traditions and ties; with the great task of solving an experiment in Government on a huge scale; with a vast wilderness to subdue and render serviceable to man; with the problem of assimilation of an influx of foreign population possessed of alien thoughts and customs; of a country that, as a whole, may be likened to the pioneer settler whose log-cabin is reared quickly out of the immediate material at hand for convenience and shelter only, so that he may the sooner set about the task of clearing his land and gaining his livelihood. Should accumulated wealth later bestow upon him or succeeding generations its independence of labour, and the opportunity to cultivate the mind, he may then observe the stored wisdom of history, and bow to its influence and tradition.

Therefore in our country, in this condition to which I have likened it, we find the Colonial type of domestic architecture principally interpreted, not by architects nor under an artistic impulse, but by the builders of the period whose personal vagaries and idiosyncracies more and more overwhelm the meagre examples of this authoritative style. Throughout the country, and for the greater part of the nineteenth century, these conditions prevailed, for we cannot take as essentially typical the attenuated architectural movement, if it may be so described, that was discernible in a few of our more important sea-board cities. Broadly speaking, the entire scheme of things involved no application of artistic code or principle, but was merely the product of the builder-craftsman. In the older portions of the country we find the more important structures reared of brick and stone with a generally prevalent application of our own peculiar system of wood-construction to domestic requirements. Throughout the middle west, in Ohio, Michigan, Indiana, Illinois, Wisconsin, and all that region west of the Mississippi River, the saw-mill was king and the carpenter-builder its faithful apostle and exemplar. The strictly utilitarian held sway, and the rapidly-increasing population of this region had neither the time nor inclination to consider such matters as art nor the refinements of a wealthy and settled community, and thus there became impressed an habitual habit of thought, which stood for years as an obstacle to artistic growth and development. Buildings were an object of pride, and aroused interest and appreciation only because they expressed in size, in materials employed, and in numbers, the growth of a community or the prosperity of the individual. These structures, with here and there a reminiscent architectural, detail, usually crude and illiterate, were devoid of architectural sense or meaning, as were the people themselves of a proper understanding of the codified systems of artistic thought.

In this connection it does not appear to me that it is logical or permissible to trace the course of that spark of architectural knowledge which moved onward from the early Colonial days, revealing itself from time to time in isolated instances throughout this period, and claim that its description is the story of American architecture.

Personally, I prefer to deal with that which in its broader sense arises from the people, as with the seed that is sown with Nature's forces working invisibly and within, until, under favouring conditions, its growth and full flower appear. Despite their apparent indifference to artistic feeling and their devotion to material

development, these people held within them the seed of art, and during this period its germination and hidden growth was sure, awaiting! but the bursting of a materialistic, envelope to blossom into a keen love for, and appraisal of, the value of beauty and art to mankind. Manifestly this must be true of them since there were no kings, nobles nor courts to patronise the arts, no leaders of thought who could arbitrarily establish an artistic movement. The accomplishment of this could only be through the gradual dissemination of knowledge of, and love for, the beautiful throughout a people concentrated on practical problems, until they, in a unity of thought and action, should respond to the resulting impulse, thereby making possible an architectural epoch in their history.

It must be borne in mind that we are dealing with the development of architecture within a democracy, describing a movement probably without a parallel in the history of the art. Republican Venice in its day of commercial supremacy had her traditions of Rome and Greece, an old order of things to build upon, and an unavoidably inherited environment not of its own creation; of an artistic bequest authoritative in its derivation, and certain of itself.

We are dealing with a nation in which no individual could so dominate as to become a mainspring of artistic action, a nation so wedded to the formula of democratic simplicity that he who would lead must become its consistent votary, a nation that expressed this habitual attitude architecturally by its wholesale neglect of the artistic excellence of its public buildings of this period.

Passing over the time of the Civil War, the reconstruction days and the panic of 1873, we find architecture at its lowest ebb concurrently with the renewal of the energetic development of railroads and of other fundamental industries, a consequent rapid increase in accumulated wealth, and of the power of the individual as well as of communities to assert their importance by a material display. The individual respected no architectural authority, save that of his own taste, under the guiding influence of the carpenter-builder. The architect was a negligible quantity, a mere speck in the background; and, in fact, the name had small significance except only when applied to the builder. An architect was a dubious being at best, who insistently expounded impracticable and useless theories about art and other effete things of European origin that were quite inimical to the interests of the local dealers, building trades, and their political henchmen. These were the controlling influences, and this was the day of diluted Eastlake and whimsical variations of Victorian Gothic, of jig-saw ornament, and of cast-iron tortured into nightmare semblances that to this day can scarcely be traced to their remote ancestry even by an expert. Under this authority, and with this vernacular, the residential architecture of the time was created, and cities and states so announced their power and importance in their institutions of learning, their capitols, courthouses and other public structures.

Thus we have before us the spectacle of democracy, with its growing newly-acquired wealth and leisure, embarking without rudder or compass to range aimlessly the broad unfamiliar stream of traditional art. Many souvenirs of this extraordinary excursion still remain with us, but, fortunately, the greater portion of the work of that day has vanished to make way for better things. The climax of this era occurred in the Exhibition buildings in 1876 in Philadelphia, and the greater part of the succeeding decade was required to mark its fall.

As a youth, the writer witnessed the fullness and the decline of this period, the beginning of the reform movement, the rising appreciation of proper standards, the sure but slow education of popular interest and taste, until to-day it may be justly claimed that the fundamental elements of our peculiar American type of architectural expression are discernible. Its precise formulation may not yet be possible, but it is a vital and growing thing, plastic, perhaps restless and unsettled, yet reflecting our rapidly-crystallising characteristics as a people. As an art, it has unquestionably found itself, and its underlying purposes and tendencies are capable of analysis and discussion. In method it is bound to no exact tradition nor architectural style, but does acknowledge the underlying principles and authoritative precedents that energise them all. For the present it is transitional in character, and, as to detail, is essentially an architecture of adaptation, wedded, as I have said, to no particular style, but seizing for the purpose at hand any suitable architectural form that applies to our situation and environment, and controlled by a trained art intelligence.

The thin skirmish-line of architects—which stretched across this artistic wilderness from the century of Bulfinch, Hogan, L'Enfant, and

others, to the century of Hunt, Root, Richardson, and their contemporaries, men who bravely maintained their loyalty to artistic purity, and devoted pursuit of art under all discouragement—has now broadened into an army of architects and artists, the product of schools of art and architecture both at home and abroad. These men are inspired by exceptional opportunity and an appreciative public. In their numbers, and the power of their collective influence upon the civilisation and development of their country, they exceed that of any similar group of men of a single generation to be found in any recorded period of the world's art development.

Here, then, we have the interesting example of an art movement rather typically American, wherein the love of the beautiful and the desire for its intelligent expression is not due to the stimulus of the patron towards the artist, but on the contrary has flowed from the artist to the patron, or rather, from an entire group of artists to an awakening public. Democracy having solved its fundamental problems, now encourages intellectual and artistic growth with a lavish patronage, that in its aggregate volume and result will some day be viewed with deep interest by the world at large. Even from the standpoint of historical analogy, the forces are at work and the material exists out of which to fashion this result.

The entire material equipment of this country which served its purpose throughout a period of transition and development must be, and is being recreated in permanent and enduring form, thereby affording an extraordinary volume of architectural opportunity. A practical people, accustomed to quickly grasping and solving broad problems by concerted action, they have realised that beauty and art are vitally important things, and that to be acquired as a national asset their guidance and direction must be assigned to that group of men whose training and experience entitle them to it, and whose active propaganda are but reflected by this conclusion.

The educational influence now at work within us is as wide as the nation itself, proceeding primarily from the group of men referred to, also from schools of art, which are to be found in every important city in the land, from the regularly-established schools of architecture in our various colleges and universities, from the active and alert efforts of the lay press, and the intelligent and interesting art-criticism and discussion of the popular magazines and the technical journals of the profession.

In this scheme of education Europe may be regarded as one great laboratory, in which the practical application of the theories and influence of this educational movement are tested and applied. The thousands of Americans who, year by year, cross the Atlantic and travel about Europe have, regardless of their immediate motive, both consciously and unconsciously, absorbed the spirit, the grandeur and nobility of its artistic achievements, and have at last perceived that, besides the material wealth of a country, there must be a spiritual and intellectual wealth which art alone can express, and without which no nation can be truly great nor the full fruition of a people's destiny be accomplished.

I believe that these influences have resulted in a public sense of discrimination and a sound professional analysis of the art and artistic influence of Europe, and from this I reason that there will ultimately appear in America a characteristic American style that will be grounded upon the varieties of architecture, sincerely expressing the organism, use and purposes of our structures, yet not insisting upon the forced and unnatural adaptation of motifs and detail in archæological reproduction of other styles not suited to ourselves. The day has passed in my country when the ideas and so-called originality of the individual are to be tolerated as a worthy substitute for the time-honoured forms and concrete conclusions which represent the cumulative authority of the many minds of the past striving for truth and beauty of expression.

That our growth and development will be to a large degree homogeneous, is to be expected, because of the ease of intercommunication and consequent habit of travel between our various states and cities. While interesting variants may appear, due to the Colonial influence of which I have spoken, there will be none of those phenomena that have in the past arisen from restricted intercommunication, isolation of cities, division of languages and customs which so strongly individualised and restricted the art and thought of European groups, and which so comprehensively affected the formation of its various styles of architecture. Speaking one language, and existing under one government, with facile and established habit of intercommunication, we are not subject to, in any given locality, the possible provincial outlook nor the requirements of local materials or customs peculiar to that locality, as is the case in Europe.

Undoubtedly the greatest, if not the primary, stimulus of the present artistic development of the United States is to be found in the Columbian Exposition of 1893 in Chicago. It was here that the profession for the first time found itself in possession of a theme monumental in its scope and dignity, and of that peculiar quality and complexity which put it beyond the capacity of the layman or of the builder to control; resulting, therefore, in its assignment to a profession now become powerful enough to assert its right to assume direction within its own domain. The initial moment in our art history that required the united action of a group of properly-trained men, it was the first time when they had to deal with a problem in which architecture was the dominant note; recognised as the visible and vitally-important expression of the dignity and scope of the enterprise. The interest of a great public was to be aroused, and a situation of charm and beauty was to be created as a functional part of the display itself, and for this purpose the business men in charge perceived that good architecture was indeed a practical necessity. For the first time the ability of architects accustomed only to separate individual effort was to be gathered together, synchronised and welded into unified action, wherein the individual tendency must be subordinated to the requirements of all while dealing with a grandiose plan, the grouping of buildings in harmony of mass and outline conforming to a central governing ideal.

For the first time on American soil there was to be produced in orderly triumph the majestic splendour of ancient Rome, of Italy, of the dreams of France, and these architects, recruited from the field of conventional daily routine, thus found in their grasp the opportunity to display to a great people the possibilities and meaning of the art of architecture.

To-day it is a thing of the past, ephemeral in its material existence, but everlasting in its message and impression upon the nation. With difficulty can you, to whom the traditions of your own land and the storied riches of Europe are familiar things, realise the revelation contained in this work of art, and its stimulus to our people.

Its direct influence is manifest in every important city of our land, by local agitation for civic beauty, by established and projected control, and direction of the art expression of individual enterprises by the popular demand for the beautifying of streets, the monumental groupings of public buildings, and the constantly increasing intelligence of popular architectural criticism.

A hitherto unknown language to the masses, this enterprise aroused in them a spirit of inquiry and appreciation, that with one great sweep of thought elevated the profession of the artist and architect into a plane of equality with all of the utilitarian pursuits of a practical money-getting age. With a public thus instructed, characteristically eager to inform itself of new thoughts and ideas, we find a typical response thereto through the columns of the daily press, the advertising of the Fair itself, and the pages of our popular magazines.

Alert in their department of public activity, they were keenly alive to this demand for knowledge, and, in turning over the files of the popular prints of the day, one may be surprised at the volume and importance accorded to this subject. For the first time the profession found itself a firmly-established part of the general scheme of things, a factor of public interest, upon which rested the responsibility of interpreting the intellectual and material growth of a community while subjected to intelligent scrutiny and analysis of its work, and in a position to deal successfully with the influence of ignorant Philistinism.

These people of practical and materialistic habit of thought responded promptly to the realisation that here indeed was a new field of development, that paid big dividends in its effect upon the physical and moral welfare of both the present and future generations.

Search as you may the current files of thirty years ago of the press of any community in our land, and no reference will be found therein to architecture or any other art as being of public import or interest. To-day our important metropolitan newspapers maintain a regularly-established department devoted to illustration and comment upon the current architectural products of their vicinity, and the newspapers of the smaller cities display a keen interest in their local art movements.

To me this is a fact of deep significance, knowing as I do the power of the public press in our land, which not only leads and formulates, but likewise reflects public opinion. From this awakened artistic consciousness, no longer concerned with art as an abstract question but as a matter of practical importance, there arises a stimulus which imposes upon each architect, when dealing with an important project, a responsibility so seriously involving his own

personal prestige as to remove him from the field of irresponsible effort. Our building regulations and various movements towards the establishment of art commissions as a part of the organisation of city, state and national government, are effective in their way and undoubtedly important, but the final authority rests with an enlightened public opinion which is the product of the influences to which I have alluded.

While according to these influences their general force and direction, I cannot altogether subscribe to the characteristic attitude of the writers of books and essays about art as they apply it to architectural discussion.

We who have to deal with the everyday conditions of our art, and live with it constantly, know that our feet are mired in the clay of practical, materialistic, and unlovely things, which cannot be tossed aside like the painter's canvas, nor the sculptor's sketch, if we find our artistic progress impeded.

Our ability to apply our art, knowledge, and skill to these things should be, in a large measure, taken as a matter of course, and—like the ability to play the piano which a composer must obviously possess—a means to an end, in our case too often overwhelmingly utilitarian.

Those who review our work for literary purposes generally fail to penetrate this realm of professional routine and practical impedimenta, and we find them wandering about in the abstract discussions of the studios, arriving nowhere, and quite as apt to be of harmful influence as otherwise.

It is my purpose, therefore, to discuss our contemporaneous work from this perhaps unimaginative and realistic standpoint, as being essential to a correct conception of an important factor in the moulding and the formation of a typical American architecture, and without which it cannot be truly appreciated nor understood.

I love to soar to the heights with an imaginative writer when addressing himself to our stubbornly practical art, for it does us both good, but unless he belongs to the Brotherhood, and, like myself, has to get back to earth again, the return trip becomes rather lonesome, particularly when I find myself humbly surveying a lot of actualities that have not been with me on the voyage. I believe that these actualities, that are our common fate and with us every day, are unitedly a component force reacting upon our artistic desire and instinct, which will finally produce a resultant force that may become differentiated as an American style. Of these two forces the artistic theory has been pretty thoroughly exploited, but I believe that the workings of the force, which I term "actualities," should be accorded equally prominent attention. As to the resultant force, have we now in America, that formulated habitual expression of feeling and characteristic assemblage of detailed forms —a vernacular if you please—or an evolved system of massing, grouping of parts, or of proportion having a sufficient individualism of our own, to be designated as an American style? Obviously, this resultant does not yet exist, and indeed may be a creature of very slow growth, but it certainly is in the making.

In the buildings erected during the past twenty-five years, we have run the gamut of practically all known architectural thought—have experimented with about everything this side of the Indian wigwam. This has been done, not because of any lack of inventiveness on our part, nor of imagination, nor again does it suggest any feeling of satisfaction with such a state of affairs. We realise that we are dealing with something much more important than passing fads in millinery, automobiles, or dress, and that eventually this indiscriminate borrowing of other people's architectural garments must be succeeded by a costume more fittingly our own.

Considering, however, the prevailing circumstances surrounding our profession throughout this period, it becomes immediately apparent that my previous observation is reasonable concerning the causative action of our practical "actualities."

The incredibly rapid growth of our cities, increase of population, the demand for a new equipment of buildings of every variety of use and purpose, the razing of existing buildings, products perhaps of a previous decade, but become obsolete and in the way of imperative necessities, constituted a movement of such overwhelming volume, to be accomplished in such a short space of time, as to crowd upon the shoulders of one generation of architects—who virtually at the same time were recreating themselves — a variety and volume of new problems, complicated in their every practical aspect, and presenting an entirely new artistic field of attack, that perhaps would not have been an easy task for three generations of men well intrenched amidst familiar traditions.

Again, the entire absence of suitable precedent or style, and the presence of a prevailing and

entirely new form of construction having no European prototype, obviously presented a free range for the exercise of individual fancy, resulting ofttimes in incongruity and an inharmonious eccentricity and lack of restraint. Owing to the ever-increasing height and the form of our buildings—a subject of great importance to which I shall give special attention —new problems in the scale and application of detail were presented, which resulted in many architectural catastrophes, but are now better understood.

Owing to all of these conditions the successful architect found himself burdened with an extraordinary and varied assortment of buildings difficult to deal with at one and the same time, with the demon of American rush-methods relentlessly pursuing him—regarded by all of our highly-organised and efficient building trades as a sort of human rubber-stamp that worked automatically — what else could he do but throw up his hands in despair, with one backward look of envy towards the old monks who constructed a few feet of cathedral in a generation, turn archeologist, and plaster his steel skeleton with a tidy arrangement of architectural dope, calculated to soothe the owner, the public and the contractor, making everybody perfectly happy, but the poor architect left alone with his sadly disfigured ideals?

It is my personal belief that this has had much to do with the exploitation of certain historical styles by several of our notable architects; to the extent that their names have become synonymous with those styles, as, for example, Richardson with the French Romanesque.

It is an undertaking that requires no small amount of executive ability, and a highly-organised office successfully to manage this condition, and whatever tends to standardise and unify its efficiency must perforce be found and used.

Richardson, with his masterly knowledge of the style, was quite justified in his adherence to the Romanesque. It was not too violent a departure from the prevailing mode, was easily managed by the building trades, and suitable to the then existing range of available building material. How clearly he perceived this is proved not only by his own work and by that of his immediate successors, who were trained under him, but also by the complete collapse of the movement he established when it fell into the hands of the horde of imitators who neither saw nor appreciated the importance of this fact, and who, in attempting novelties of treatment without proper means at hand, helped it to an early death.

Our next important architectural revelation fared more fortunately by proving itself much more adaptable to our wants, and, dealing with an almost infinite variety of refined flexible forms easily applied, became the reigning fashion for an extended period, and is to-day reasserting itself in a salutary and refreshing way.

This revelation came through the work of White and of MacKim, who did not at first display a full mastery of the style, but temporised with a curiously interesting architecture of brick and reserved application of Italian detail. They soon became the leading exponents of the Italian Renaissance, and since their output of residential, commercial, and other classes of work, was enormous, its educational influence with us must be counted of prime importance, and by their own good taste, fine sense of proportion, and full appreciation of the refinements of the style, they elevated our standards to a plane that will not be abandoned. In their extensive use of the Georgian period they reminded us of our own best tradition, showed us the value of simplicity, control of expression, and respect for architectural law and order. Office expediency is to me apparent in much of their work, particularly in their bold confiscation of entire architectural compositions, as for example, in the Tower of Madison Square Garden.

With us the first important exponent of the modern French school of thought and design was Richard Hunt, and his work was of such volume, his clientele so important, as to place him as one of the factors that shaped our tendencies. His earlier work adhered closely to the contemporaneous French Renaissance, but later his frequent and facile application of the style of Francis I. to noteworthy structures produced a widespread interest in the style. His high place is accorded him, not only because of the importance and quality of his work, but also for his sturdy maintenance of the best traditions of the French school, which now have become so important to us.

These men were great artists whose inspiration, given to the young men of their day, now become the active men of this day, and to the whole trend of architectural thought in the official, governmental and private life of our country, cannot be overestimated.

It is important that I refer to the aims, influence, and results of the system of

architectural education prevailing in our colleges at home and of the foreign schools, notably that of the Beaux Arts of France. Our courses are largely influenced by the Beaux Arts system of instruction, and the theory of architectural training as formulated by it. Better than any other, it seems to us to concern itself with the broad principles of architecture, of the laws of composition, mass and proportion, the proper use of ornament, and emphasises the comprehensive grasp of problems of a nature comparable to our own. Furthermore, it has evolved a technical method of expressing these things so intelligibly that it is peculiarly suitable to the student, first grounding him in principles and then developing in him the power to individualise his interpretation of them. It is this insistency upon principles, and freedom from exploitation of any particular style or fad and the resulting flexibility, which popularises this school of training with us. The general result of this organised system of education is already apparent, and will, in our succeeding architectural generation, mark the greatest forward step in the right direction that we have yet known. Already the sobering influence of logical thought based upon this training in principles is visibly impressing itself upon our buildings, to their infinite betterment, and revealing a firmness of touch and a sure handling of design. There is forming a unanimity or trend of thought that is replacing the scattered individual assertiveness of style that was characteristic of former days, which presages a typical American mode that will continue and prevail as a foundation for consistent development. I believe that the English influence and traditions will be always more in evidence in our expression of domestic architecture, because our habits of living are modelled upon the English customs, with particular reference to country life. Our public buildings, and our disposition of the larger civic architectural problem, will undoubtedly exhibit more decidedly than ever the French influence and system.

In the field of commercial buildings, we have presented to us our own peculiar characteristic American problem, and out of it we are developing our own positive contribution to architectural form.

Unlike the Gothic architecture, with its organic union of construction and design, it partakes of one characteristic Gothic quality, namely, the emphasis of the vertical and subordination of the horizontal line in composition. But again, it requires a superficial envelope, a simulacrum inclosing and concealing the real structural elements beneath, and in this respect becomes analogous to the arcuated construction of the Romans with its outward application of Greek forms and orders.

That we should have indulged in architectural flounderings and fantasies with such a problem as this to deal with is not to be wondered at when all things are taken into consideration.

Our most unruly problem, the tall building, is, from my way of thinking, the result of the logical working of the law of supply and demand. It is neither fantastic, avoidable nor useless, nor will it yield to adverse legislation, because public necessity formulates a public opinion that will not legislate.

It is amusing to read in the publications of fifteen years ago the diatribes against it and prophecies of its early extinction which were provoked by the modest fifteen and twenty-storey structures of that time. The architect of the then tallest building in New York announced in print his belief that the end of tall buildings was in sight. Structures of twenty-five, thirty, forty, and even more than fifty storeys have been the answer. It furnishes a typical example of practical necessity and mode of existence creating a movement which ends in something distinctively characteristic of a people, and in this instance steel-construction and the tall building is affecting us as did the round arch and vault of the Romans. The business centres of such cities as New York and Chicago, as created to meet the conditions of 1860 to 1870, were soon outgrown, and the necessity for larger and better buildings became apparent. The established business centres could not be, or at least were not, moved, property values and the existing inter-relations in those centres being of too great moment at the time.

This generally prevalent condition produced different immediate results in different sections of the country, which long since have converged into an established common practice.

In Chicago, we find that the direct causes that led to the first example of true skeleton construction were (*a*) the necessity for increased height; (*b*) which the character of the supporting soil rendered impossible on account of the weight of the then prevailing type of massive masonry walls and interior columns, and which could not be overcome unless (*c*) a system of construction be devised stronger and of less weight than other types, which was

accomplished by the device designated by us as the "Skeleton Steel Construction."

Had this been the only merit possessed by this type, it might have remained a localism of Chicago, or at least it would not have become the highly organised, complex, and widely adopted construction that it is to-day, practically amounting to our accepted type for commercial purposes.

The system, as developed, is a simple one in principle, consisting of supporting columns of steel or cast-iron, braced in all directions and riveted or bolted to the horizontal girders and beams, which not only support the floor construction but, more important still, also carry, storey by storey, the outer walls of the structure, which thus cease to have constructive value, becoming a thin screen of material that serves to enclose the building and to protect the steel fabric from exposure.

The outer walls being but screens, the masonry supporting nothing, their piers were in consequence easily reducible to a minimum surface width and the area of glass could thus be largely increased, thereby giving a maximum lighting to the interior, a device rendered necessary by the generally increased height of our buildings fronting upon streets that could not be increased in width. The effect of this condition is manifest in the earlier treatment of the architectural design of these structures and has become typical of them in the work of the present day.

The walls, being non-supporting, could be reduced to a minimum thickness, thus providing an important addition to the interior area of each floor, and materially increasing the earning power of the building; an imperative necessity because of the rapid rise in ground value in central business districts.

None of this development would have been possible, however, if it had not been for the American type of elevator, which was promptly developed in response to this new demand, and has kept pace with it ever since by evolving new principles of construction and operation necessary to cope with the constantly-increasing height of buildings and the enormous increase in service both as to speed and volume of traffic.

These foregoing advantages, meeting our conditions and requirements, led to the general widespread adoption of this system, resulting in the development of remarkable contracting and building skill and organisation, of which we have every right to be proud, and which has produced amazing results as to speed of construction, quality of work, and economy. With our high ground values and the necessarily great earning power of these structures, the saving of time in their erection became a matter of momentous importance, and this necessity led to the creation of the skill and organisation referred to.

This type has come to stay because of its attributes of structural endurance, safety, economy in first cost and of upkeep, and its general suitability to our modern conditions.

While it has belonged to the domain of the architect, becoming the accepted type for our huge hotels, apartment houses, and commercial structures, and under his direction is fast becoming a thing of grace and beauty from a beginning of sprawling ugliness, nevertheless it must be said in all fairness that these structures could not have been devised without the skill and genius of our mechanical and structural engineering professions, the builders and the skilled mechanics, whose trades have become specialised and developed by this demand, all united in effective co-operation with the architect.

The question is frequently propounded: "Are these structures beautiful, or can they be made so, and thus enter the realm of artistic thought?" In my opinion the answer is emphatically, yes. It is no conclusive argument to decry them because in certain communities people live and pursue their vocations in such a manner as to make this type of building unnecessary, or because, since they have thereby been enabled to restrict the height of all building to a lower level, producing a uniformity of general effect, they can then point to Paris as the grand example of this sort of thing, and claim her artistic virtue as their own. Beauty of this sort is the outgrowth of suitability to local conditions, plus the artistic thought that may be apparent in the means adopted, but it is, after all, only one kind of beauty. There is beyond question the beauty to be found in truthful picturesqueness, when it is a natural outgrowth of conditions inherent in the people, and it can be made quite as respectful of architectural law, and the result of individual effort being made with regard to the effect of the whole, while working in this freedom of spirit, as though it were hemmed in by ironclad restrictions as to height, etc., that are characteristic of certain communities.

The development of the exterior treatment of the tall building, architecturally, has been

exceedingly interesting, and in the time and space afforded to me in this discussion cannot be described in detail. The stereoptical views, and the comment thereon, which I have to present, will illustrate the subject in a more effective manner.

Briefly stated, our fundamental principle in design seems to have become established by treating the tall structure as a column with its base, shaft and capital. In all of the best and most pleasing examples of the later work this element appears, and we find the lower storeys grouped in a single architectural composition supporting a long vertical and shaft-like series of storeys grouped into a simple treatment that carries the eye upward without interruption to the crowning feature of the entire design, which again is a series of storeys combined into the capital, as it were, of the mass. The pleasing variety of thought in the handling of this scheme of treatment is one of the best features, and generally speaking is now characterised by a sober refined self-control and a truly architectural spirit. In the classic feeling of the Italian Renaissance, the municipal building of New York is unquestionably one of the best solutions of the problem on these lines that we have, while in the West Street building and in the Woolworth building, both in New York, we have equally good examples of the application of Gothic feeling and detail. Considering its extraordinary height and unusual mass, the design of the Woolworth building is in my judgment an architectural achievement of the highest order. I have referred to these buildings not only because of their architectural merit, but also for the reason that they represent the two broad schools of design which seem most suitable to the problem presented by the tall building, and are, I believe, typically representative of our lines of future development.

In pointing out the consummation of this century and a half of architectural growth in my country, I would have you enter the harbour of the city of New York on a trans-Atlantic liner, and from that point of view for the first time observe the buildings of the lower end of Manhattan Island with their towering and amazing sky-line and mountain-like mass of architectural grouping, picturesquely artistic and truthfully expressive of the spirit of our lives and activities.

I believe that it will grip the imagination of any observer, whether he sees it for the first or the hundredth time, and that he will experience from it that flow of thought and impression which is produced only in the presence of some great and inspiring thing. To me it illustrates the quality and the character of our people, their aspirations, and their peculiar genius in terms of architecture, as do our mountains and valleys, our lakes and rivers, the physical character of our land. Prosperity, wealth, and power we are surely possessed of, and we are as surely acquiring from the artistic wisdom and traditions of Europe that which is useful and good for us to have, and are applying it intelligently to our needs. As a people we are learning to respect and revere Art, and to value its uplifting influence, and with these fundamentals to build upon, and with the artistic forces that are ever active amongst us, the future of American architecture will be worthy of high regard.

DISCUSSION.

The CHAIRMAN said those present would agree that Mr. Andrews had delivered an absorbingly interesting paper on American architecture. It was wonderful to reflect that, as he had said, in 1873–4 the Americans were still without any manner of their own, or any decided leanings, in architectural design, so that in the last forty years they had developed the wonderful work which had been illustrated on the screen. When he came to the meeting he thought he knew something about American architecture, but he now found that he was altogether out of date; three or four years had elapsed since he was there, and that was a long time. The tall buildings of that date had been eclipsed, and the 700-ft. buildings had been erected since he was there. When he was in New York he did not think the American architects were themselves quite sure as to the possible final success of those buildings, and they were always asking Europeans what they thought of them. He never felt any hesitation in declaring that he thought them extremely fine, though he believed the Americans to whom he said it sometimes thought he was chaffing them. The effect of them upon him was very strong; and when the streets were fuller of them, and there was an aspect of greater cohesiveness, the effect would be better still. But when he was there, the tall buildings were only occasional, so that the effect was somewhat "jumpy." Looking down town in New York at that date reminded him very greatly of the streets of Genoa and of other of the older Italian towns. The New York streets were wider, but the buildings being higher, with the overhanging cornices, there was produced the same effect of deep shade at the bottom, and brilliant light on top. Fine as one thought such buildings out there, he did not think our admiration for them would enable us to imitate them in England

—our atmosphere and our requirements seemed so different. But it was important to note how keen was the interest taken by the American public in matters architectural. Here the public did not generally take much interest in those matters, and the reason might be that Americans had had that new problem to solve. Our problems had been settled, and most excellently, in days gone by, and at present we were somewhat nervous about trying new ones. In America architecture was a topic of public conversation, and one could hear comments upon the beauty of design of the buildings. That was, naturally a great encouragement to the artists working in brick and stone, an advantage which Britishers congratulated them upon possessing. Another advantage was the unified action in that country; they were all working on the same lines there, though not necessarily on the same style; sometimes they used the Gothic, sometimes the classic; but the buildings were so huge that the detail in them was a comparatively small matter. The buildings were designed with the idea of great effect, a great base, a great shaft, and a great cap; and each was trying to bring about the same effect in his own individual way. That was an advantage which was seen in all countries in the world in the matter of architecture. In Greece, for instance, they worked together on the same lines, and they achieved success; and so in Rome, and in the Renaissance and in the English Gothic. When working together with the same aims, success followed, which showed that architecture was an associated art, and that a Copyright Bill was scarcely necessary or desirable for architects. What was required was that they should assist one another by their examples, and thus by degrees develop something which should be not only satisfactory to themselves, but should bring honour and repute to the countries in which the buildings were placed. The history of our country was largely built in its architecture; and the history of America was now, he thought, being largely, nobly and grandly built by American architects. He was, therefore, sure that the meeting would join with him in congratulating Mr. Andrews and the American people on the magnificent opportunity they had had. He knew very well Mr. MacKim, of the firm of MacKim, Mead and White, one of the most charming men who ever stepped, as well as one of the most modest and refined. When he (Sir Aston) was in New York, Mr. MacKim had just finished the library for Mr. Pierpont Morgan, one of the most refined buildings, of ordinary size, which he had ever seen. A New York City man told him that constantly on going down town he went out of his way for the pleasure of going down the street to look at the elevation of that library—a very strong illustration of the effect which architecture might have upon the individual. He also had the pleasure of knowing Mr. Cass Gilbert, whose very fine buildings the lecturer showed on the screen. Mr. Gilbert was also a great artist and a most delightful man. There was one omission in the slides, and that was an indication of what buildings were designed by Mr. Andrews himself. If he showed any of them, he did not say which they were, a piece of information he was sure they would be glad to have.

Mr. H. H. Statham, F.R.I.B.A., cordially supported the expression of thanks to Mr. Andrews for his interesting paper and pictures. He had received new light that evening on the conditions of American architecture, because although he knew the position of Manhattan Island led to the crowding of the ground, he was not previously aware that the resulting buildings had been accepted as the type of American architecture. He admired those buildings, and he agreed that they were the natural outcome of the conditions, but it was impossible not to feel some dissatisfaction with the idea that they were buildings of which the whole exterior more or less imitated a construction which was not the real construction; and if that system of building tall steel buildings was to be made architectural there should be some effort to design the exterior, so that it actually conveyed to the mind that it was only steel; that it should avoid giving the impression that it was an imitation of a stone structure. Was it possible to carry out those high buildings in ferro-concrete, instead of with a stone skin, so that the exterior should represent the actual construction? Pictures had not been shown of very high buildings in concrete steel. To Europeans, who had been accustomed to regard architecture as buildings in stone and brick, that idea of the outer skin went against one's prejudices. He had the feeling that he would like to see the exterior aspect of a building represent its actual construction. His own feeling had been, in regard to many of the buildings illustrated, that the base, from the architectural standpoint, was not strong enough. Probably that was also a question of light; but if larger piers were put in the basement it would have a better effect. What had been said about the influence of tradition in American architecture was very interesting. He thought American architects had given themselves over too much to the cult of the Beaux Arts, and if they would try to evolve a style of their own it would be well. If one adopted the general feeling of classic forms, one might put something into them which was in harmony with them, and yet not necessarily copying.

Mr. John Slater, F.R.I.B.A., desired to endorse what had been said as to the interest of the paper. Three years ago he went to New York, and he felt what Mr. Andrews had said as to the imposing effect of the high buildings when seen from the river. The fact that the gaps between them were now being filled up was a very good feature, because to stand in one of the narrow streets and look over a low building at the side of one of the lofty structures was one of the most

depressing things which could be imagined. With regard to some of the pictures shown, especially of the purely utilitarian structures, he thought a sufficient attempt had not been made to emphasise the corners. One building was rather alarming to look at because of the thinness of its corner. Notwithstanding the necessities of lighting, if those structures were to be put up it might be possible to give a little more apparent strength to the corners. It was very interesting to hear about the stimulus towards the artistic appreciation proceeding from the artist to the patron. He feared that the patron in America gave more fertile grounds for those stimuli than in this country; but there could be no doubt, from what was known about the spread of architectural education in the States, and the way in which the various colleges and municipalities were providing for the proper education of art students, that the intelligent appreciation of architecture was greater in the States than here, and that was a matter upon which the Americans were to be congratulated, while we must deplore the lack of it in ourselves.

Mr. ANDREWS, in reply, expressed his warm appreciation of the way in which his paper had been received. He hoped that when next his hearers saw anything which pertained to the work of the United States, the paper would help them to understand what it was that had caused it to be with all its faults—and he hoped some virtues—what it was, and the directions in which the country was tending. He would not wish those high buildings put in any part of Europe, because they had nothing to do with their conditions or mode of life, and they would be an entire misfit. They belonged to America, and were not freaks. The freakishness would be eliminated from them by educating the landlord and the public, when the former allowed the corners to be made wider and to occupy more space.

HOME INDUSTRIES.

State Insurance.—The further discussion of the National Insurance Bill has proceeded upon lines favourable in the main to the scheme, whilst disclosing many matters of important detail that cannot be reconciled one with the other. Part II. of the Bill, which deals with Unemployment, is, perhaps, the more doubtful section of the present proposals. In introducing the Bill, the Chancellor of the Exchequer said that many efforts had been made on the Continent, "mostly failures, because they are all on the voluntary principle." This is a mistake. By a happy coincidence Mr. J. G. Gibbon has just published "Unemployment Insurance," a study of schemes of assisted insurance. Mr. Gibbon has carried on his investigations in connection with the sociological work of the University of London. A draft of the book was completed about the middle of last year, but Mr. Gibbon decided to await the receipt of the new material which would be available in connection with the International Conference on Unemployment which was to be held in Paris in September. The reports prepared for the Paris Conference provide a rich store of material, from which Mr. Gibbon has drawn freely. In a brief preface, Professor L. T. Hobhouse says that "the most important result which emerges from Mr. Gibbon's investigation is the contrast between the success of the Ghent system of insurance and the difficulties and failures that have beset other experiments. One of the great merits of this system is that it dispenses with compulsion, and this is of the more interest for us because under British conditions compulsion would probably encounter peculiar difficulties, and if it can be dispensed with the whole problem will be sensibly lightened." Compulsory insurance against unemployment has been actually tried at only one place, St. Gall, Switzerland. Full particulars of its operation will be found in a "Report to the Board of Trade on Agencies and Methods for dealing with the Unemployed in certain Foreign Countries," by D. F. Schloss, 1904, p. 143, and in "Insurance against Unemployment," by D. F. Schloss, 1909, p. 8. Mr. Gibbon tells us that a law was passed in 1894, in the Canton of St. Gall, which authorised any Commune to set up a scheme of compulsory insurance against unemployment. Insurance could be made compulsory for all workmen earning not more than 4s. a day, unless they were equally insured otherwise, and could be made optional for persons earning more. The local authority could also make insurance compulsory for women. The scheme was in force in the town of St. Gall for two years. It was then abandoned, mainly at the instance of the better class of workmen. It was badly conceived and as badly executed. There was no adequate check of unemployment. Persons drew benefit who had no legal right to it. The scheme was administered by the Poor Law Department, and therefore became connected with the poor law in the minds of the people. The better class of workmen, from the beginning suspicious of the scheme, became the more bitterly opposed to it when they saw the abuses which arose. Commenting upon its failure, Mr. Gibbon remarks that it is unfortunate that it should have been necessary to discard the one scheme of compulsory insurance against unemployment which has actually been put into practice, largely because of palpable defects of administration, without a fair test of the principles on which it was based. Direct experience, so far as it goes, is against compulsion. Only one such scheme has ever been tried, and that signally failed. Proposals to establish compulsory schemes have been considered at several places, but not adopted. At Basle, the electors in 1899 rejected a compulsory scheme by referendum after it had been passed by the legislative body.

Unemployment Benefit.—The extent to which unemployment benefit actually exists is not generally appreciated. In the report of the Board of Trade on the work of the trade unions of the

United Kingdom during the years 1905 to 1907 it is estimated that in all some £514,000 was expended during 1906 by trade unions in the United Kingdom in unemployment benefit. This sum was disbursed by some 750 trade unions. Particulars published in *The Labour Gazette* show that over £1,000,000 was expended by the 200 principal trade unions in unemployment benefits in 1908, and over £940,000 in 1909. During the ten years 1900-9, unions included in the principal hundred provided in all over £5,500,000 in benefits of this kind. In some industries, mining especially, slackness is met by working short time, and therefore comparatively little unemployment benefit is paid. The benefit paid in the several trade unions differs very considerably. In many of the more skilled trades the rates of benefit are not very high, but the period for which benefit may be received is long. Thus a member of the Amalgamated Society of Engineers of over ten years' standing can receive 10*s*. a week for fourteen weeks of unemployment, 7*s*. for the next thirty weeks, and 6*s*. a week for the remaining period of unemployment. The average annual expenditure per head of membership in eight of the principal unions for the years 1898 to 1907 was: London Compositors 29*s*., Ironfounders (England) 24*s*., Boilermakers and Shipbuilders 19*s*., Amalgamated Carpenters and Joiners 16*s*., Amalgamated Engineers 14*s*., Cotton Spinners 12*s*., Typographical Association 11*s*., Durham Miners 3*s*. These figures give the actual average charge on members in respect of unemployment pay. In two instances the amounts provided were over 5*d*. a week per member, in three instances over 3*d*. a week. These payments are made to provide against one of the several contingencies of a workman's life. In some industries the practice is to work short time when trade is slack, so that little is paid in unemployment benefit, even when the total unemployment is high. The thirteenth abstract of labour statistics shows that the average unemployment for the ten years 1899 to 1908 for all the trade unions making returns was 4·3 per cent. In the shipbuilding trades it was 9·5 per cent., in the building trades (carpentering and plumbing) 5·9 per cent., in the furnishing trades 5·8 per cent., in the engineering trades 4·8 per cent., in the printing trades 4·6 per cent. In 1899 the percentage of unemployment for all trades was 2 per cent., which would make necessary a contribution of about 2½*d*. a week to provide a benefit of 10*s*. a week for unemployed persons, whereas in 1908 the percentage of unemployment was 7·8 per cent., which would have made necessary a contribution of about 9½*d*. Much has been done by the trade unions to assist the unemployed, but much remains to be done. It has been estimated that "probably 6,000,000 or 7,000,000 men over twenty years of age belonging to the classes from which trade unionists are drawn have not yet joined a trade organisation." This from the report of the Poor Law Commission, Part VI., chap. 4, para. 592. Only 1,500,000 workers are insured, and even of these many are but meagrely insured.

Curtailment of Production of Cotton.—The suggestion is made in Manchester of a general arrangement to close the mills one day per week until margins improve, and it would seem desirable that cotton spinners should agree to put a check upon yarn production, seeing that the quantity of raw cotton in this country and on the way here may not be sufficient to see them through until the present crop arrives. What is wanted in the cotton trade is the organised curtailment of production when trade is unprofitable. Too much yarn is being produced, and unreal reports of conditions of trade are used to support speculators in their actions. Production was reduced by the numerous cotton mills spinning coarse and medium counts, which use the major portion of the cotton crop. What good reason is there for the continued working of mills at a loss? The gainers are the cotton brokers, manufacturers, and yarn agents. Why should the spinners bear the drain of maintaining them? The decisions of the International Conference should be acted upon.

Hire-Purchase of Lace Machinery.—The Parliamentary Committee of the Nottingham Chamber of Commerce are investigating the question of hire-purchase of machinery. In Nottingham there are numbers of factories with several tenants and a common water-supply, the building sometimes being owned by firms or individuals who are not lace manufacturers at all. For instance, the Clyde Works are owned by the Clyde Works Company, Limited, and there are twenty-six firms housed in the premises engaged in net, curtain, and other trades. According to Mr. F. B. Stabel—a well-known Nottingham man in the trade—under existing conditions a man can purchase two lace machines for £1,000 each, paying £50 down on each machine, with the result that "a lot of men of straw embark in the lace trade who have no business in it." If financial difficulties arise the machinery is seized by those who supplied it, and there is nothing wherewith to meet other indebtedness. Of late there have been several cases of the kind, not only the machine being claimed but also the yarn "in process."

The Aluminium Convention.—This Convention was formed last February, and it has run its course. The agreement was between the Neuhausen Company, the French makers, and the British Aluminium Company, but it made no direct attempt to regulate production, and no penalties appear to have been attached to the breaking of the terms, the most important of which related to the maintenance of a standard price (136 marks per 100 kilos). The arrangement was for three months only, and the French works having notified their unwillingness to renew the contract the Convention expires. It was thought when it was brought about that it might serve as the basis on which to found a more efficient organisation, but it has not worked well.

The Oil Trade Rivalry.—The rivalry between the competing oil companies shows no signs of

abatement. Of late years, and outside the Scotch Mineral Oil Companies, the three great distributing concerns have been the Anglo-American Oil Company, which represents the Standard Oil Company; the British Petroleum Company, representing the Royal Dutch-Shell Transport interests; and the Home-Light Oil Company, originally known as the Caucasian Petroleum Export Company. The Home-Light Company's British interests have now practically passed to the British Petroleum Company, and between this and the Standard Oil Company the conflict is fierce. Throughout the past burning-oil season retailers in the most distant districts have been able to buy oil at less than 3*d.* per gallon net. And the competition is keen in motor-spirit as well as in burning-oil.

GENERAL NOTES.

LECTURES IN ADVANCED ENGINEERING. — A course of five lectures on "The Application of Hyperbolic Functions to Electrical Engineering Problems" will be given at the Institution of Electrical Engineers, Victoria-embankment, by Dr. A. E. Kennelly, at 5.30 p.m., on May 29th, 30th, 31st, and June 1st and 2nd, 1911. The lectures are addressed to advanced students of the University of London, and others interested in the subject dealt with. Admission will be by ticket obtainable on application to the Secretary of the Institution.

PRODUCTION OF ELECTRICITY FOR MOTIVE POWER IN ITALY.—The use of electricity for motive power for industrial purposes has increased to an enormous extent during the last ten years in Italy. This is especially noticeable in the production of electric energy by water-power as compared with that furnished by steam, gas, or by other heat motors. In 1900 the total energy produced amounted to 82,000 horse-power, whilst two years later it had nearly doubled, being 157,000 horse-power, of which 92,000 horse-power was supplied from power-stations driven by hydraulic power, and 65,000 horse-power by steam or other heat engines. The following statistics show the rapid increase in the amount of electric power furnished yearly up to December 31st, 1909:—

	Horse-power by hydraulic motors.	Horse-power by steam, etc.	Total horse-power.
1903	101,000	80,000	181,000
1904	139,000	100,000	239,000
1905	190,500	125,000	315,500
1906	245,000	155,000	400,000
1907	383,000	195,000	578,000
1908	409,000	225,000	634,000
1909	510,000	240,000	750,000

It is estimated, in consequence of the completion of many important power-stations both in the north and south of Italy, that the total production of motive power did not fall short of one million horse-power. The following returns of the number and horse-power of engines employed in the mining, metallurgical, and chemical industries in 1909, give some idea of the importance played by electricity in this country:—

	No.	Horse-power.
Hydraulic motors	945	67,876
Electric motors	1,457	44,301
Steam engines	1,245	94,098
Gas engines	465	31,493
Oil, etc., engines	20	599
	4,132	238,367

REGULATIONS FOR WIDTH OF WHEEL-TYRES IN ITALY.—The following regulations respecting the width of the tyres of wheels for vehicles, in relation to their weight, in use on public roads and highways in Italy have been issued lately:

For Two-wheeled Vehicles.

Gross Weight, Vehicle and Load. French. Quintals.	English. Tons.	cwts.	lbs.	Width of Tyre. French. Centimetres.	English. Inches.
6	—	11	91	4	1·57
10	—	19	77	6	2·36
20	1	19	42	8	3·14
50	4	18	49	12	4·72
For Four-wheeled Vehicles.					
10	—	19	77	4	1 57
15	1	9	59	6	2·36
30	2	19	7	8	3·14

Weights exceeding the above and up to 70 quintals (6 tons 17 cwts. 91 lbs.) may be carried on wheels having tyres of india-rubber or other elastic material. Special permission from the competent authority must be first obtained should the loads exceed 70 quintals in weight.

THE CORROSION OF METALS.—A recent Australian invention to overcome troubles of corrosion and pitting in metals, especially boilers, due to electric chemical action of ingredients in water with which they are brought in contact, appears to have met with success in Sydney, according to the American Consul there, and the owners of this invention have just made arrangements for its thorough test by the Canadian Pacific Railway in some of its engines in districts where there has been much trouble from boiler corrosion. The plan of the invention is to introduce, by dynamos, weak electrical currents on to the metals intended to be protected, thus neutralising the galvanic action of the corrosive substances contained in the water. The process can be worked from any electrical installation already in use, the amount of electricity required being extremely small and such as can be easily regulated. The process is intended to be specially used, not only for the protection of boilers, but also for protecting condensers, digesters, feed-water heaters, tanks, tail shafts, stern frames of ships, etc. The invention is expected to make an immense saving by eliminating the necessity

for using zinc in various forms, boiler fluids, etc., to combat corrosive tendencies, and also in dispensing with retubings and other repairs. This new electrical process was recently tested by the Professor of Physics at the Melbourne University on metals immersed singly and in connected pairs in sea water, both hot and cold, and in dilute acids, who reported that all hurtful galvanic action was suspended by a small expenditure of electrical power. Successful trials have subsequently been reported, says the Consul, by engineers of the Melbourne Steamship Company, the Sydney Municipal Powerhouse, and the Union Steamship Company of New Zealand.

THE PALM-FIBRE OR "COGOLLO" INDUSTRY IN VENEZUELA.—The palm-fibre, or, as it is locally known, the "cogollo" industry, has for many years been of great economic importance in Venezuela, particularly in the Maracaibo district. There are districts where the majority of the families depend upon this product for a livelihood. The fibre is obtained from a small palm called "palma de cogollo." Only the young shoot or centre leaves are gathered. The first cutting can be made when the plant is one year old, and thereafter from two to three times a year. After the leaves are gathered they are placed in large earthenware jars. These jars are then filled with water, to which has been added the juice of three or four lemons, and the fibre is allowed to soak for six to ten days to remove all vegetable saps and resins. After this the leaves are spread in the sun for several days until they are bleached to a cream-white. They are then made into bundles weighing about two pounds each, and are ready for market. The leaves are soft and pliable, and are split into narrow ribbons, which, when moistened, may be rolled into a string-like form, and then woven into hats. The hats made from the Venezuelan cogollo are practically the same as the so-called "Panama" hats, but are seldom so fine-grained or well made as the Ecuadorian or Colombian hats.

TECHNICAL EDUCATION IN BRAZIL.—The Brazilian Government have recently authorised a system of schools and stations to teach agriculture in the several States, in harmony with the plan for apprenticeship trade-schools. At the head is to be a higher school of agriculture and veterinary surgery, with seat at Rio de Janeiro. The school will give education fitting students for places as experts in the general extension of agricultural training. With the co-operation of the State Government, agricultural schools, experimental stations, model farms and stock ranches will be established as soon as the general working out of the plans justifies such work. Elementary instruction in rural industries will be encouraged in schools for elementary education already established. By demonstrations at experimental stations and elsewhere it is intended to instruct farmers in the use of modern implements and methods necessary to success in farming.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 29...Indian Guild of Science and Technology, King's College, Strand, W.C., 8.15 p.m. Dr. Bidhau Chandra Roy, "The Public Health Problems in India."

Surveyors, 12, Great George-street, S.W., 5 p.m. Annual Meeting.

Geographical, Burlington-gardens, W., 8.30 p.m. Professor W. L. Grant, "The Geographical Conditions affecting the Development of Canada."

North-East Coast Institute of Engineers and Shipbuilders, Bolbec Hall, Westgate-road, Newcastle-upon-Tyne, 7.30 p.m. 1. Discussion on Mr. P. B. Newell's paper, "Some Problems relating to the Use of the Internal Combustion Engine for Marine Propulsion." 2. Discussion on Mr. Joseph Chilton's paper, "Some Notes on the Speed and Power of Machine Tools."

TUESDAY, MAY 30...Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. W. Watts, "The Ancient Volcano of Charnwood Forest, Leicestershire." (Lecture I.)

WEDNESDAY, MAY 31...Public Analysts, at the Chemical Society's Rooms, Burlington House, Piccadilly, W., 8 p.m. 1. Mr. H. Droop Richmond, "The Composition of Milk." 2. Messrs. Cecil H. Cribb and P. A. Ellis Richards, "Notes on the Analysis of Margarine." 3. Messrs. Cecil Revis and E. Richards Bolton, "Observations on some Methods of Estimating Cocoanut Oil and Butter in Butter and Margarine." 4. Messrs. T. Cockburn and J. W. Black, "The Estimation of Quinine as the Acid Citrate, in certain Organic Liquids." 5. Mr. R. W. Clarke, "The Determination of the Amount of Dissolved Oxygen absorbed by Sewage Effluents containing Nitrite, and of the Amount of Nitrite in Sewage Effluents of Water." 6. Messrs. Cecil Revis and E. Richards Bolton, "Further Analyses of Ghee."

Concrete Institute, 296, Vauxhall-bridge-road, S.W., 5.45 p.m. Mr. R. W. Vawdrey, "Reinforced-Concrete." (Lecture VI.)

Mining and Metallurgy, at the Institution of Mechanical Engineers, Storey's Gate, S.W., 8 p.m. 1. Mr. C. O. Schmitt, "Future Economies in Rand Reduction Plants." 2. Mr. Arthur C. Hoare, "The Roasting of Complex Ores in Gold Assaying." 3. Mr. G. M. Austin, "A Prospector's Method of Gold Assay."

THURSDAY, JUNE 1...Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. R. M. Caven and H. J. S. Sand, "The Dissociation Pressures of the Alkali Bicarbonates. Part I. Sodium Bicarbonate." 2. Messrs. J. J. Dobbie and A. Lauder, "The Absorption Spectra of Cinchonine, Quinine and their Isomers." 3. Messrs. C. R. Crymble, A. W. Stewart, R. Wright and Miss F. W. Rea, "The Influence of Conjugated Linkings upon General Absorptive Power. Part II. Some Open-Chain and Cyclic Compounds." 4. Mr. F. Tutin, "The Constituents of the Bulb of Buphane Disticha." 5. Mr. J. Weir, "New Derivatives of Aminolauronic Acid." 6. Messrs. M. O. Forster and S. H. Newman, "The Triazo Group. Part XVIII. β-triazoethylamine." 7. Messrs. C. F. Cross and E. J. Bevan, "The Interaction of Formic Acid and Cellulose." 8. Mr. A. McKenzie, "Configuration of the Stereoisomeric Dibromosuccinic Acids. Preliminary Note."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. T. Thorne Baker, "Changes Effected by Light."

FRIDAY, JUNE 2...Royal Institution, Albemarle-street W., 9 p.m. Commendatore G. Marconi, "Radio-telegraphy."

SATURDAY, JUNE 3...Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. L. Courtney, "Types of Greek Women." (Lecture I.)

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FRIDAY, JUNE 2, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

CONVERSAZIONE.

The Society's annual conversazione took place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday evening, May 30th. The Reception was held in the Central Hall of the Museum by Sir John Cameron Lamb, C.B., C.M.G., Chairman, and the following members of the Council:—Sir Steuart Colvin Bayley, G.C.S.I., C.I.E., Mr. Alan Summerly Cole, C.B., Mr. William Henry Davison, Mr. Robert Kaye Gray, Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., The Hon. Richard Clere Parsons, Sir Boverton Redwood, D.Sc., F.R.S.E., Mr. Carmichael Thomas, Professor John Millar Thomson, LL.D., F.R.S., Sir Aston Webb, C.V.O., C.B., R.A., F.R.I.B.A., and Colonel Sir John Smith Young, C.V.O.

The following portions of the Museum were open:—The Central Hall, containing cases of specimens illustrating mimicry; adaptation of colour to surrounding conditions; protective resemblance, etc.; the North Hall, containing the collection of domesticated animals; the Bird Gallery, containing groups of British birds and nests, etc.; the Fish Gallery, the Shell Gallery, and the East and West Corridors on the first floor.

A selection of music was performed by the band of H.M. Royal Regiment of Artillery, under the direction of Mr. E. C. Streeton, Bandmaster, R.A.

A vocal and instrumental concert was arranged in the Shell Gallery, and a miscellaneous entertainment was given in the Fish Gallery, under the direction of Mr. Patrick Kirwan.

Messrs. Steinway and Sons kindly lent two pianos for use at the concert, etc.

The number of visitors attending the Conversazione was 1,292.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A Meeting of the Indian Section was held on Thursday, May 25th, 1911, the Right Hon. the Earl of Minto, K.G., G.C.M.G., G.C.S.I., G.C.I.E., in the chair.

The Chairman said he had great pleasure in introducing the reader of the paper, Mr. Merk. Mr. Merk had had a very distinguished career—so distinguished that his lordship could not trust himself to recapitulate offhand the various appointments he had held. He practically began his political duty in the Afghan Campaign of 1879-1881, where he did excellent service, which was recognised by his appointment to the Punjab Government Secretariat. Subsequently, in 1884, he joined the Demarcation Commission of the Anglo-Russian Frontier as Attaché, and was with the Commission the whole time it was on duty, and for his services with it received, in 1887, the C.S.I. He then became Deputy-Commissioner of Peshawar, and all who knew the frontier realised that this was a most important post; and when we took over the Kurram Valley, in 1892, he was appointed its first administrator. His lordship was there quite recently with Mr. Merk, who had revisited his old haunts; and he thought he could honestly say that the prosperity of Kurram was largely due to Mr. Merk's administration. After that, Mr. Merk was in supreme political charge of the Mahsud Expedition in 1902; they had been told not to call it an expedition, but a blockade. After that, he returned to the Punjab, and latterly had been acting as Chief Commissioner of the North-West Frontier Province. Mr. Merk was a most accomplished linguist in many languages, and naturally possessed a very thorough knowledge of Pashtu. His lordship was glad to see him so vigorous and in good health, and he hoped he had many years before him yet in which he would be able to render still further service to the country, which already owed him so much.

The paper read was—

THE NORTH-WEST FRONTIER PROVINCE OF INDIA.

By W. R. H. Merk, C.S.I., LL.D.

The North-West Frontier Province, on which I have the honour to read you a paper to-day, is the youngest, if we except Eastern Bengal, of the Provinces into which British India is divided, having been constituted in 1901. In respect of population, and of the extent of territory that is fully administered according to the British law, it is also the smallest; but I think one may safely claim on its behalf that no other Province excels it in interest.

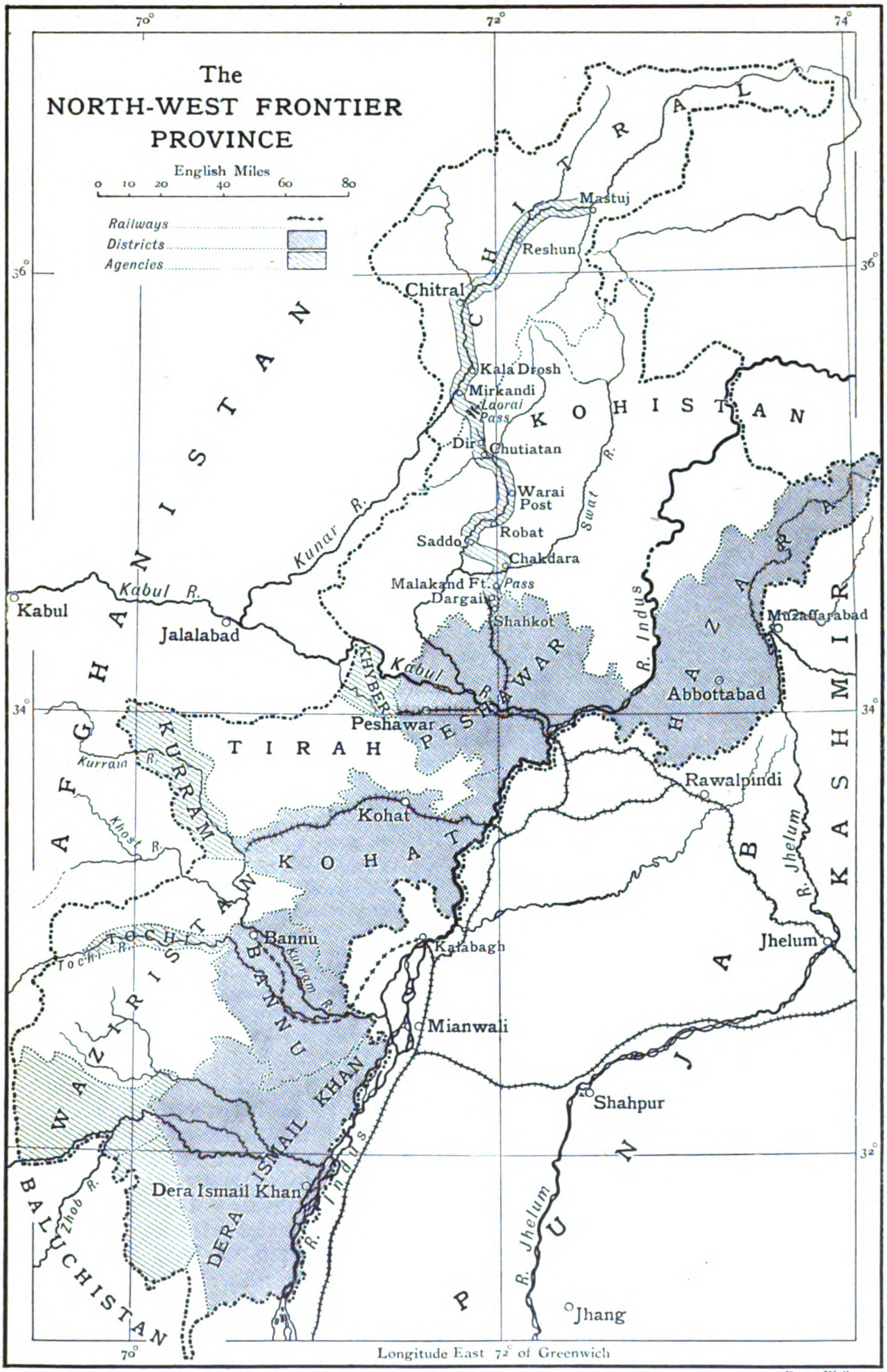
The gates of India towards Central Asia must ever have an attraction of their own. We are here on classic, historic ground. In dim, pre-documentary times, there poured through the gaps of its western ramparts that race of highly-gifted Asian shepherds and cultivators who gradually rescued India from the hold of the dark Dravidians, and founded an ancient and enduring civilisation, the highly-developed religious and philosophic creeds of which have from time to time exercised a profound influence upon the Western world. The passes beyond the Indus have given admittance to such orderly conquerors as Alexander the Great and Baber, the Great Mogul, whose aims were to construct rather than to destroy. The furious onslaughts of Mahmud of Ghazni, that shattered the stately edifice of civilisation in Northern India reared during many centuries of Buddhist and Brahmanic care, were first delivered in this neighbourhood. The blood-thirsty hordes of Chinghiz Khan, Tamerlane, and Nadir Shah, which wrought such hideous ruin in India, passed through this Province; as did the last invasion of Northern India, when Ahmed Shah and his Afghans came down, only 150 years ago, to crush for ever the hopes of the Mahrattas and to pave the way for a new development: the advance of another orderly conquest and of a high civilisation from the sea to the hills, from the east and south towards the west thereby reversing the processes of past ages.

To students of history, this part of India possesses a peculiar fascination. It is not without great attractions for those who are called to take an active and practical part in life, whether as soldiers or as civilians. The extraordinary diversity of scenery and terrain within the limits of the Province; the wild and martial character of the bulk of its inhabitants; the question of eminent importance which is presented in the problem of how to tame and civilise the Albania that forms its greater portion; the desperate struggles that have occurred in its hills; the achievements of Nicholson, Edwardes, Reynell Taylor, and Cavagnari, Lumsden and Wigram Battye of the Guides, Mackeson and Abbott and Neville Chamberlain—all combine to create a glamour which it would be difficult to match elsewhere in India, and which fires the imagination of the frontier man, of whatever race he be. It is well, in a way, that this should be so, for life on the frontier is by no means always a bed of roses.

As the Province has come into being only recently, it may be convenient to give you a few statistical facts in connection with it, which will afford a general idea of its circumstances. The first thing that strikes one is the length of the charge as compared with its breadth; the second is that, from an administrative point of view, it comprises two totally distinct and dissimilar forms of jurisdiction, to which there is no parallel elsewhere in India. Taken together, they considerably enhance the gravity of the task that is laid upon the administration; the first difficulty can be overcome by improving to the utmost the means of rapid communication, and much has already been accomplished in that direction; the second difficulty will find its solution in the course of time; what that solution will be no man as yet can say, but it is at any rate permissible to suggest that it should be conducted on peaceable and conciliatory lines, if that is in any way honourably possible, and provided that the force of circumstances is not too strong for us owing to unforeseen exigencies or to the wilful opposition, one might almost term it the insanity, of the people concerned themselves.

The North-West Frontier Province lies between the 31st and 36th degrees of latitude, and the 69th and 74th degrees of longitude; or, to be less technical, it stretches for over 400 miles as the crow flies, from the Pamir Steppes, the Roof of the World, to a point south of the latitude of Lahore, the capital of the Punjab.

I have alluded to the diversity of topographical conditions in a Province, the highest point of which lies in the eternal snows at an altitude of 25,000 feet above the sea and the lowest portion of which, at Dera Ismail Khan, descends to 400 feet from sea level. Every kind of climate, vegetation, and physical aspect can be found here. In the north lies the barrier of the



Districts are indicated by dark shading, Agencies by light shading.

glistening peaks and enormous glaciers of the Chitral ranges, their sides scored by narrow glens and tremendous gorges; further south we come to the well-wooded hills of Bajour, Dir, Swat, Buner, the Black Mountain, and Hazara, enclosing fertile, smiling valleys, and in Hazara affording an ample selection of sites for sanatoria; next comes a remarkable physical division of the terrain, which has had an important political bearing, in that the plain has always been more or less under a settled government, whereas from time immemorial the hills have been independent. From where the Indus emerges out of the northern group of mountains to the point where it leaves the Province a plain flanks its proper right bank. In the Peshawar district this plain widens into a great bay in the shape of a horseshoe, encircled by hills, which was evidently the basin of a former lake. After the mighty river has forced its way through a relatively low transverse range, the plain reappears in the districts of Bannu and Dera Ismail Khan, and so continues to the sea. It slopes up to the western hills at a varying breadth of forty to sixty miles, and is at first cut up by deep ravines and rocky hills (the raiders' opportunity), till these gradually melt into a flat and dreary expanse of waste and desert, with which many of you must have been painfully familiar. To the west of this plain, from Peshawar to the southern extremity of the Province, lie masses of wild and rugged hills, often rising into ranges of great height, such as the Sufed Koh and the magnificent Takht-i-Suleman, a country of precipices, cliffs, and inaccessible glens. Rarely do these widen into fertile and irrigated dales. Speaking of the tract south of Kurram and Kohat, Baber, who knew a good deal about it, records:— "There are, perhaps, scarcely in the whole world such dismal-looking hill countries as these; they have all a uniformity of aspect, being very low, having little grass, bad water, and not a tree. It is an ugly and worthless country." I do not think many will contradict him. But there are other sides to the picture. Few who have seen the valleys of Kurram or Peshawar in the spring will forget the exquisite beauty of the landscape; and the sight of a thunderstorm sweeping across the plains of Bannu is a momentary compensation for existence on that lonely rock, Sheikhbuddin. Even the jagged peaks and cliffs of Waziristan and the wide deserts at their base are not without a sterile grandeur. I cannot resist quoting to you a piece of descriptive writing (by Colonel James, who fifty years ago was Commissioner of Peshawar) which portrays a typical bit of frontier scenery, and is as true as it is fine:—

"Those who have travelled much among the Afghans, and visited them in their sequestered valleys, retain a pleasing impression of the general characteristics of their homes. Emerging from wild and craggy defiles, with a solitary tower here and there perched up on the overhanging rocks, the stranger comes suddenly upon the village site; springs of refreshing clearness pass from rocky cisterns to the brook which had repeatedly crossed his path in the defile, and which is here fringed with rows of weeping willows and edged with brightest sward. The village is half hid from view with overhanging mulberry and poplar trees, the surrounding fields enamelled with a profusion of wild flowers and fragrant with aromatic herbs. At some distance is seen a wood of thorn and tamarisk, in which are the graves of the village forefathers; an enclosing wall of stone, and the votive shreds which are suspended from the overhanging tree, pointing out the 'ziarat' of some saintly ancient, which children pass with awe and old men with reverence. The dream of peace and comfort, which the contemplation suggests, is, however, rudely dispelled by the armed ploughman, who follows his cattle with a matchlock slung at his back; by the watch-tower occupied by a party of men to guard the growing crops, and by the heaps of stones visible in all directions, each of which marks the spot of some deed of blood. We cease, indeed, to be surprised at the love of home, which is so marked a feature of the Afghan character; for, reared in a little world of his own, the association of his childhood must make a more than ordinary impression on his mind, but we might expect that such scenes would engender other feelings than those which lurk in the breast of the robber and assassin. . . . Their hills are full of sacred spots, and upon the tops of mountains, hid in clefts of rocks, placed on the roadside, where a spring issues from the earth or where a clump of trees affords unwonted shade, the rude grave is to be found of some holy man deceased, adorned with white stones and pebbles, where the sick resort to be healed, and those who are bound on any enterprise, to pray, and where at times may be seen the solitary lamp, kindled in gratitude by one who has slain his enemy or gathered unusual spoil."

The upper half of the Province is drained by the rivers of the Indus, Swat, Panjkora, and Kunar; the three latter fall into the Cabul river, which itself swells the volume of the Indus at the old Moghul fort of Attock. Their junction during floods is the scene of a wild confusion of waters, about two miles in width, before they are compressed into the gorge by which the Indus bursts through a range of low hills, past Khushalgarh, to spread itself over the country beyond. There, at Dera Ismail Khan, during the season of the rains and melting of

the snows, it may attain a width of over ten miles. The southern half of the Province can boast of few perennial streams. The principal are the Kohat, Kurram, and Tochi rivers, and the Gumal—as a rule, modest affluents of the Indus but apt, like the generally dry hill watercourses of this region, to come down in terrific spates after unusual rain. As with the rivers, so with the rainfall; it is heaviest in the north and steadily diminishes towards the south. In Chitral it is 17 ins. in the year; lower down we come within the area affected by the monsoon, and in the Hazara district it is 45 inches, but at Peshawar 12 inches, the same at Bannu, and only 8 inches in Dera Ismail Khan. Excluding the Hazara district and the northern hills, the cultivation which is dependent upon the rainfall alone is most precarious, and water supplied by irrigation is the life of the people, a subject to which I shall revert presently.

In this land of rocks and stones one would expect to meet with valuable minerals, but except some orpiment in Chitral, an inferior marble in the Peshawar district, the huge deposit of grey rock-salt in Kohat, where it occurs in the form of veritable hills, and some good coal near the Indus in the Bannu district, there are none. It is possible, however, that paying quantities of oil may be found in the Sherani hills, at the extreme southern border of the Province; if so, that will revolutionise the economic conditions of that arid region and provide much employment with the means of livelihood for the hungry and idle hillmen of the neighbourhood.

The greatest breadth of the Province is 280 miles, but that is an extreme case; on an average the territory in question is from 100 to 150 miles wide. The contrast with other compact Indian Provinces is obvious. The total area comprised within its limits is, in round numbers, about 38,000 square miles, or somewhat more than three-fifths of the size of England without Wales. But only 13,000 square miles (one-third of this tract) are under full British law and administration—that is to say, are what is commonly understood by the expression "British territory." By far the greater part, or 25,000 square miles, is occupied by tribes who are under British political control, but who maintain their internal or municipal independence. The British territory part of the Province is divided into the five districts of Hazara, Peshawar, Kohat, Bannu and Dera Ismail Khan. These districts stand almost entirely on the same footing as districts lying Cis-Indus in respect of laws and justice, revenue system, education, excise, police, and the thousand-and-one items that go to make up the sum total of our administration in India. Whether at the beginning it would not have been better to have introduced a more simple system, more adjusted to the special wants and circumstances of a rough frontier people and country, in a then out-of-the-way corner of India, it is somewhat late to consider now. It is not easy to set back the hands of a clock that has been running for sixty years. Vested interests, rights and obligations have arisen and become established that must be respected, and a sudden or general reversal of the course of administrative evolution might lead to greater evils than those that it would be sought to rectify. But it is quite possible to retard excessive elaboration; and doubtless in some departments of the administration, such as the revenue system, it is feasible to simplify. I may note here that steps are now being taken in that direction. How this state of things came about it is not difficult to understand; on the annexation of the Punjab the present frontier districts were included in that Province; from which, as I have said, they were separated only nine years ago. Being in the Punjab the districts were treated on the same administrative lines as the Cis-Indus portion of that Province in which, however, during the early years that followed the Sikh wars, the system was anything but intricate and elaborate; it was rough and ready, and the personal element in the governing of the country predominated. Across the Indus, as can be imagined, this patriarchal state of things was accentuated—"it was a far cry to Lochawe"—and the local hakim or ruler represented all authority in the minds of the people. Even long after the administrative system had crystallised in the Punjab proper, it remained more or less fluid across the Indus, and when I first went to the frontier, thirty-three years ago, it was still considered to be far behind the rest of the Punjab. Gradually that charm that centralisation and bureaucratic methods possess for the human, and especially the Oriental, mind—there is no such bureaucrat and red-tape clerk as the Oriental when he gets his chance, and the preponderating bulk of our staff is Indian—almost insensibly began to assert itself, and the frontier districts came in for their share of the administrative elaboration that has taken its rise of late. Even so, in matters of justice, it was found that concessions were necessary to the special

conditions and difficulties of the frontier, and forty years ago a tentative step was taken by the introduction on a very circumscribed scale of the "jirga" system. Fifteen years ago it was considerably amplified, and, with further extensions adopted in 1901, that system is in full force. Briefly the "jirga" system is this: in civil claims over questions that fall within the sphere of tribal custom, and in all criminal cases before they have been finally decided by a regular court of justice, the chief civil authority in a district can, in his discretion, refer the matter for the verdict of men, viz., the "jirga," selected by him and conversant with the subject of dispute or with the circumstances of the criminal charge—much as the British jury, in its origin, consisted of men who were acquainted with the facts and being upright, could assist the King's Courts by stating what they knew to be the truth; not by way of evidence in the capacity of witnesses, but as judges by way of finding. It will be realised that the success of such a system rests mainly with the people themselves, it lies in their hands to make it by honest verdicts or to mar it by perverse, factious, and corrupt proceedings. The regulation or law that enacts the "jirga" system contains safeguards against its abuse; also various powers are given by it for the preservation of order and the support of authority in a turbulent tract. With the details of these I will not trouble you. It is sufficient to note that the special conditions of a frontier country have so far been recognised in their judicial aspect. And, as already mentioned, the simplification of the revenue system is in course of being carried out.

In these districts the King's writ runs as freely as all over India. They have, therefore, been marked by a dark shading on the map. Their western boundary, which is known as the administrative border, and which I would call "the inner provincial border," is a sinuous line, which extends for some 600 miles. All along this great distance it is exposed, potentially, at every point to the inroads for plunder—the forays—of the warlike tribes that live beyond it; but, as is natural, there may be, and generally is, a profound peace on most of it even when there are lively times at one particular point. I would ask you always to remember when you hear the border is disturbed, that raiding at one spot does not necessarily mean widespread unrest or a conflagration, any more than the battle of Sidney Street in London implied a general action going on down Prince's Street, Edinburgh. On the other side of the inner border there dwell the municipally independent tribes who are under the political control of the Chief Commissioner, which he exercises with the aid of the officers in charge of the five Political Agencies—viz., Swat, Dir, and Chitral; the Khyber; Kurram; Northern and Southern Waziristan. These Agencies, which are marked by a light shading, can be described as the five fingers or tentacles of civilised order, stretching into a mass of barbarism and savagery. In between the Agencies, the space left white—which, however, is by no means emblematical of innocence—is that which is occupied by the independent tribes as far as the "Durand line" or "the outer provincial border." This line separates the respective British and Afghan spheres of political influence and control, and was accepted by the Governments concerned in 1893. It has mostly been demarcated; the greater part of the still undelimitated section lies along the watershed of high mountain ranges. The length of this outer border cannot be less than 800 miles. Except in Kurram, and in lesser degree in the Tochi valley of the northern Waziristan Agency, both of which tracts have been brought to some extent into line with British districts and pay revenue, the King's writ applies in the Agencies only to those who have been born in British districts and are technically British subjects. The tribes are very wisely left to manage their own affairs themselves; but no offences are permitted on the British roads, and the efforts of our officers, in so far as they do not relate to these roads, are confined to preventing general tribal fighting that would tend to close the roads or to cause serious complications.

The population of the five British districts, according to the census of 1901, was 2,040,000 souls, and is probably now some 2,200,000. The density of population per square mile varies greatly; for the Province it is 113 persons, in the Peshawar district it is 249, and falls as low as 61 in the district of Dera Ismail Khan. In England it is 606 per square mile. What the population is between the inner and the outer borders it is impossible to state with any approach to accuracy, a census being out of the question. Taking the density of population in Kohat and Kurram, which are tracts that approximate closely to the conditions of the territory in question, and allowing for the vast uninhabited areas of the mountains round about Chitral and for the deserts of Waziristan, also for the relatively dense populations in Swat

and Tirah, I think an average of sixty persons per square mile is near the mark. If so, the population of the outer portion of the Province, 25,000 square miles in extent, is about 1½ million souls, which, at the rate of one in five, gives 300,000 fighting men. In some respects this sounds more formidable than it is; at no time, and for no joint purpose, could all this mass of men combine for collective action. drawn as they would be from innumerable different clans, torn by family and tribal feuds, living in a tangle of mountains, over a length of at least 600 miles of country, without a recognised head or leader, and jealous to the death of each other. Moreover, armed though they be, the hillmen have not the slightest wish to meet cavalry and artillery in the open. No doubt, in former ages they swarmed down for the loot of India. But this was in the wake of the regular invading armies of the day, and only to the tune of a few thousand tribesmen at a time. There is no instance of the fate of a battle or other event, or of the course of history, in India having been affected by the tribesmen as such.

In this long and narrow Province the question of good and rapid means of communication is of the greatest importance; chief among them is the railway. There is no such civiliser as a railway. The course of events a generation ago, trans-Indus, would without doubt have been very different if the railway had been pushed on to the limit of the Empire without delay; and it is difficult to believe that, whereas there were railways in India before 1857, it was not till 1881–82 that the locomotive appeared in Peshawar—it took over twenty-five years to arrive there from Calcutta. I remember the sensation its appearance caused among the hillmen; how crowds of Afridis used to stream down to Peshawar and squat all day, perched like crows, on every vantage point, watching the wonderful engines. Since that day there has been good progress. After the border war of 1897, a line, originally for military reasons, was laid from Nowshera to the foot of the Malakand Pass. It has developed into an artery of commerce to an extent that justified its conversion from a narrow to a broad gauge. The railway, which crosses the Indus at Kalabagh, and, *via* Kohat, reaches Thull at the end of the Kurram valley, has greatly stimulated trade. A third line to the base of the hills is under construction; it will be taken over the Indus at Kalabagh and carried to Bannu. It is intended to tap the local trade and open the coalfields that I have mentioned. When the Thull railway has been extended to the head of the Kurram valley, when a short line has been constructed in the Hazara district and a lateral branch been provided from Bannu to Tank and Dera Ismail Khan, the Province will be well equipped with rapid means of communication. In their way, Pathans are keen business men; they are fully alive to the benefits of railways, and the running of trains to Bannu is eagerly awaited by the people of the district and their neighbours, the Wazors. In a wild country a railway has, by the way, a powerfully sedative effect, which all makes for peace and order. Railways are for us what roads were to the Romans. With the latter the Province is not badly provided. In this connection it may be well to emphasise what has been done by the British Government for trade with Afghanistan and Central Asia during the past two decades. Prior to 1878 this trade found its way between India and Afghanistan—the one a fully and the other a comparatively settled State—as best it could through the belt of independent territory that intervenes, and its best was bad. A little traffic trickled, over the roughest mountain paths, through the disturbed tribal limits of Chitral, Dir and Swat, to the Peshawar valley. The Khyber had been closed for many years—in fact since 1817—and caravans plying between Peshawar and Cabul struggled through the arid and waterless Mohmand hills, crossing the Cabul river twice on their road, and paying such blackmail and escort money as the Mohmands could extort. The Kurram valley was certainly, in a fashion, open under Afghan rule, but the western portion of the Kohat district in days before 1878 was not safe, and in any case the trader had to march through sterile wastes all the way to Rawul Pindi before he touched the Grand Trunk Road, or, since 1879, the railway. The Tochi valley was absolutely shut. Till 1894 the Gumal route, which is the southernmost and, after the Khyber, the most important of the trade routes on this frontier, was annually the scene of embittered struggles between the Mahsuds and the Ghilzai traders who forced their passage down in autumn and up in spring, with their families, camels, and flocks of sheep. The Powindahs, as they are called, marched in large bodies of thousands, moving, like regular armies, through the enemy's country; women, children and animals in the centre, and fighting men in advance, on both flanks and in the rear; while the Mahsuds hung round them like wolves, cutting up stragglers and pouncing on camels and sheep. Occasionally

there would be a pitched battle with heavy losses when some particular cause inflamed the hatred of both sides. All efforts of the Powindahs to effect a *modus vivendi* by the payment of passage money were fruitless. This hardy race of merchants had for generations literally to fight their way through the passes. In 1878 the Khyber was reopened for trade; in 1892 the Kurram valley, which had been closed to traffic since 1880, came under British administration and became again a road for trade. Shortly afterwards, in 1894-95, the Chitral, Tochi, and Gumal routes were permanently opened to commerce. Since those dates, excellent metalled roads have been driven from the inner border to the western limits of the Agencies, peace and security are maintained by armed forces in the pay of the British Government, wrongs are, as far as is possible, redressed by British officers, and railways have already been, or are being, brought to the eastern terminations of the routes. It is no mean impetus to prosperity that we have achieved by establishing five secure lines of trade through independent territory. The total value of the trade which is thus facilitated is about £2,000,000 to £2,250,000 sterling, and would, no doubt, be much greater but for the fiscal policy which prevails in Afghanistan and Russian Central Asia. The Frontier Province must always owe its commercial importance to the fact that it lies across the great routes that connect the markets of India with Central Asia and Afghanistan.

Of the total area of 13,000 square miles comprised within the inner border, 6,000 square miles are unculturable, and only about 4,500 of the remaining 7,000 are, on an average, cultivated; this is owing to deficient rainfall and absence of a sufficient water-supply for irrigation. The unirrigated but cultivated area amounts to 3,200 square miles, chiefly in the Hazara district, where the rainfall is abundant. The total irrigated area is about 1,000 square miles, of which some 800 square miles are irrigated by canals. In this latter area it is gratifying that about 340 square miles, or over three-eighths of the total area under canals, owes its existence entirely to the action of the British Government. It is irrigated by the Swat, Cabul river, and Paharpur canals, which have been constructed by us. An additional and bold work is in course of execution, which will add a further 300 square miles of irrigation. The Swat river is being tapped in Swat itself, and the water will be taken by a long tunnel under the Malakand Pass. Where the tunnel ends on the southern face of the range, the fall will permit of an electric development of 20,000 horse-power, which will be available for industrial enterprise hereafter. This new canal will be finished, it is expected, four years hence. All this canal irrigation—which will extend to 1,300 square miles, of which 630, or nearly half, will have been created by the British Government—lies in the dry tract in which the average rainfall is less than 15 ins. in the year. The remainder of the canal-irrigated area in the Province is watered by small and very numerous cuts, which were made by the people centuries ago, according to a rough local system of levels, and which are managed by the people themselves. In the Peshawar and Bannu districts, where the pressure of the population upon the canal lands is enormous, the soil most fertile, and the supply of water somewhat scarce and precarious, the irrigation system is arranged on wonderfully intricate but admirably practical, just and efficient codes of irrigation rules; they go so far, in many cases, as to lay down the very hour during which a man may water his field, in rotation, every week or fortnight. These codes date from pre-British days, and are remarkable instances of how the pressure of a common need can compel the most quarrelsome and cantankerous of men to unite for a joint purpose. They have been recorded by the revenue settlement officers, and one of the blessings of British rule is that the frequent disputes over water-rights admit of swift and peaceable decision by the revenue staff; whereas in Moghul and Sikh days the season for irrigation was the time for busy sniping and battles among villages. Here water is gold to the cultivator; every spring, hill torrent, rivulet, or brook, the drainage of marshes, every drop of available water, is utilised with the utmost care, and no ruler is better remembered than he who has added to the irrigation supply of the people. Intimately related to this question is that of famine, the nightmare of India. Owing to the permanent nature of what irrigation there is, and to the mobile and enterprising disposition of its inhabitants—the surplus of whom, instead of staying at home to the congestion of the consuming public, goes off without hesitation to seek an honest or other livelihood elsewhere—famine has never afflicted the arid frontier.

Cultivation, allowing for the laziness of Pathans, is much the same as in the northern Punjab, and so are the crops, excluding fruit. The climate and soil of the frontier are excellently adapted to fruit culture, and the export of fruit to India, which has been immensely developed by

the railways, amounts now to nearly 4,000 tons a year. Haripur, in Hazara, the Peshawar, Kohat, and Bannu districts are the principal fruit-growing centres, and the local government is paying much attention to the advancement of this very profitable branch of cultivation. The land tenures, in so far as they do not relate to Pathans, are similar to those in the north of the Punjab. The Pathans hold the largest amount of land in the Province; almost exclusively in Peshawar, Kohat, and Bannu; they possess a great part of the land in Dera Ismail Khan, and only in the Hazara district are they in the minority of landowners. With them the tenure of land is based upon the clan-system. Every true-born Pathan must belong to a tribe, and within the tribe to a clan, and within the clan again to one or other of its sections. Each tribe occupies a certain definite area, and to each clan and section thereof is told off a defined portion of that area. Every member of a clan has a fixed share in the clan holding; that share is his hereditary portion in the joint weal or woe. The shares of the families may all be equal, they may be unequal; but whatever they have been, that they remain; and it is in no man's power to alter his share as of right except by the unanimous consent of all the shareholders concerned—that is to say among Pathans, never. But land owned according to ancestral shares may be and is constantly bought and sold; and it can very well happen that a man has ceased to be a land-owner and yet possesses a potential share which, if his section should acquire fresh land, comes instantly into active operation. It follows that clan landowners hang together; it is not easy for outsiders to acquire land among their holdings, which fact, coupled with the pre-emption law, explains why there was no need for the Land Alienation Law where the Pathans are strongest. Logical concomitants of this system are that, in fairness to all the shareholders, each should have his allotted portion of good and bad lands, and that from time to time a redistribution of the sectional or clan or even tribal holdings should take place. This latter process, called the "vesh," or distribution (of lands), by lot generally, has been adduced as a proof of the Jewish origin of the Afghans; it is nothing of the kind, but is a phenomenon which is not uncommon in the early land tenures of many European nations who are without doubt not descended from the Lost Ten Tribes. As the "vesh" is obstructive to improvement in agriculture, it has been stopped long ago in British districts. It is still in force in some parts of independent territory, where it is rarely accomplished without bloodshed. So inherent is the share system in the life of Pathans that for a man to prove that he is a Pathan it is necessary or sufficient, as the case may be, for him to establish that he is entitled to a share in a clan-holding; if he is, then the rest follows *ipso facto*.

Of the population in the five districts, 92 per cent. are Mohammedans, and nearly one-half are Pathans; the rest are mainly of Indian stock. Beyond the inner border probably 99·5 per cent. are Mohammedan, and over 80 per cent. are Pathans. In the districts, especially trans-Indus, the Pathans are unquestionably the dominant race. They are all Sunnis, and the fact that the Turis in Kurram and a few clans of Orakzais in Tirah are Shiahs indicates either their non-Pathan origin, or the fact that they are descended from former adherents of the Roshaniya sect, of which more presently. By the force of circumstances they probably turned to the Shiah faith when the sect was rooted out, rather than join their Sunni persecutors. Of languages in the Province there are many, corresponding with its conglomerate of races—the *débris* of many a people and petty state which have been swept aside or submerged by the successive streams of invasion. In the north the tribes of the Chitral glens preserve ancient languages that have nothing in common with neighbouring tongues except an Aryan origin. In the inaccessible highlands of the Swat valley and the defiles that flank the Indus, other aboriginal relics speak little known languages. The Gujars, or cowherds of Swat, Dir, Buner, and the high ranges of Hazara still use an old Indian dialect which is believed to have been the language of the former Gujar kingdom that collapsed many centuries ago. From Dir southwards to Dera Ismail Khan, "Pakhto," or "Pashto," the language of the Pathans, holds a supreme linguistic position; it is spoken by all the residents of independent territory without exception, and by over 1½ million people in the districts. Below Pakhto, so to speak, in the districts are two distinct variations of Punjabi; the southern one, spoken principally in Dera Ismail Khan is specifically known as Jatki. Finally, in the heart of the Mahsud country, and surrounded by a Pathan tribe, a small colony of traders and artisans speaks a little-known language called "Urmuri." It is quite unconnected with Pakhto, is spoken nowhere else but in a valley near Cabul, and of

it one can at present say no more than that it is probably Iranian. "Pakhto" itself is undoubtedly an Aryan language, which goes far back to the distant days when different branches spread from the parent stem. Very few works have been composed in it, and those that do exist being little read, it is practically an illiterate language, and is spoken with perfect grammatical accuracy by every true Pathan.

Although there are local and tribal differences of pronunciation, and occasionally differing words are used for household and agricultural implements and other subjects of that kind, all Pathans understand each other without difficulty. There are two classes of pronunciation rather than distinct divisions of the language, viz., the hard and the soft, the characteristics of which are well exemplified in the two forms of the name for the language, "Pakhto" and "Pashto" respectively. A line running east and west, roughly along the Thull-Kohat railway, divides the two; to the north of this line the hard variety is spoken and the soft prevails to the south. Pashto is an occasionally harsh, but virile, expressive and sonorous tongue, which lends itself very well to political oratory--witness those who have been obliged to assist at the interminable arguments and harangues in "jirgas," or tribal parliaments.

Naturally on the frontier, among a population inured to arms and long accustomed to view all learning with contempt, if not with horror as regards Western learning, preferring the sword to the pen, education is not in an advanced condition. It is significant that in the Province the percentage of Mohammedan boys at school, to those of school-going ages, is 12, as compared with 45 and 27 in the case of Hindus and Sikhs respectively. As may be expected, female education is at a low ebb. Nevertheless, education is making steady progress; it is stretching beyond the inner border. Schools have been established in the Khyber, Kurram, and Tochi Agencies, and there are signs that the Mohammedan community is awakening to the value of letters; there is a general desire for the extension of educational facilities. Last year, for instance, the people of Kurram petitioned Lord Minto, on his visit to that valley, for the grant of a local high school. But most encouraging of all is the deep and general interest which is being taken throughout the Province in the creation of a college at Peshawar, to be called the Islamiya College. It is proposed that instruction shall be given at it in both Oriental and Western learning, in Mussulman theology as well as in modern literature and science, thus satisfying the educational aspirations of all sections of the population. It must be borne in mind that we have to contend not only with the educational inertia which is inherent in a people of warlike peasants, but have to overcome also the positive dislike, and at times hatred, which many of the powerful class of mullahs and their followers—the old school, in short—entertain for Occidental education. As a civilising and humanising agent in a country where that is a special and peculiar want, there can be no two opinions regarding the incalculable value of education. And I am glad to be able to state that the past thirty years have witnessed a complete revolution of opinion among the local upper classes in this matter. Whereas in the seventies of last century it was an exception for the sons of leading gentlemen to attend modern schools, and such a thing as an educated youth hailing from beyond the administrative border was unheard of, the reverse is now the case. Khans and Maliks, the gentry, strive to give their sons a good education, sending them to Lahore and Aligarh, as far as England occasionally, for the purpose. The Islamiya College is intended to bring to frontier doors the highest and best form of education, short of a university training. In the course of time it must exercise a most powerful influence for good, both in the settled districts and in the wild country to their west.

Between sixty and seventy dispensaries within and without the inner border, gratuitously minister to the medical wants of the people, an aspect of benevolence in administration which they duly appreciate. It may not be fully realised what we do in that direction in India. Everywhere over that vast Empire all persons can, if they like, obtain gratuitous relief at a hospital or dispensary within a reasonable distance of their homes. There is no such thing in this country, or, on so huge a scale, anywhere else in the world. That this should be provided by a Government for and on behalf of 250,000,000 of people is an astounding fact, and one which is not sufficiently recognised by some critics of our Indian administration. Speaking of the frontier, it is right to acknowledge the great work which is being done by the mission hospitals at Peshawar, Bannu, and Dera Ismail Khan. They are thronged with patients from all parts of the frontier, and even Afghanistan, and ably and zealously aid the efforts of the official institutions towards the benefit of races whose surgical

operations are of the roughest, and whose indigenous physicians follow the weird prescriptions of the middle ages.

Of the early history of this part of the world little or nothing is known with any certainty till the campaigns of Alexander the Great brought Afghanistan and North India within the knowledge of the West. On his march to India he passed from Cabul through Bajour and Swat to the Indus, carefully avoiding the Peshawar valley, except where he crossed that river. From Strabo we know his sound reasons for doing so; he struck to the north because he had ascertained that it was the more habitable and fertile country, and enjoyed the best climate. In fact, he did not descend to the Punjab till the rains had broken. Parenthetically let me draw attention to the excellence of his Intelligence Department, the most striking proof of which is apparent when his army refuses to advance any further; in the heart of the Punjab he is confronted with the necessity of marching an army 2,000 miles to the Euphrates, and is instantly able to make up his mind by what routes to accomplish this astonishing feat; not without privations and difficulties, it is true, still with success. It is clear that Alexander found the northern portion of the Province thickly populated by Indian races, who, under a settled government, had enjoyed a fairly high civilisation, which presupposes a long period of order and tranquillity. His advent did not mean ruthless destruction as practised by Turkish and Mongol invaders, but the substitution of one set of rulers and one form of government for that of another. When the East had recovered its equilibrium after his death, we find first the Buddhist dynasty, of whose members Asoka, the first Emperor of India, is the principal, and then Greeks, in possession of the parts that Alexander had traversed between Cabul and the Jhelum river. The Greeks lasted for 200 years. They governed doubtless after our fashion, the chief civil and military officers were Greeks, the coinage, and no doubt the official language, were also Greek, but the people were not touched, and appear to have lived in tranquil security. Greek artists during this period and after it, materially influenced the native sculpture and architecture; had there been strong antagonism between the few Greeks and the many Indians this would hardly have been the case. To the Greek kings followed a succession of rulers from the north, who have been variously identified as Huns, and Kushan and Scythians. Whoever they were, they were civilised themselves or else rapidly assimilated the civilisation existing on the spot, for it is evident that their assumptions of power were not associated with cataclysms. Even if we had not the testimony of the eye-witnesses mentioned below, the mass of still extant ruins of monuments and villages, the roads that were cut by the Buddhists over the Kohat and Malakand Passes and exist to this day—the latter was actually used by our troops at the storming of the Malakand in 1895—the rock-engraven edicts of Asoka which can still be read in Hazara and Peshawar, all proclaim that the country from Chitral to Bannu and from the Jhelum to Cabul must have enjoyed protracted peace and order. The halcyon time must have lasted from before Alexander's day down to about the year 950 A.D. He found the Brahmins in power but Asoka established the Buddhist faith, which endured for at least 700 years. In the fifth, and again in the sixth and seventh centuries of our era, pious Chinese Buddhists were moved to go to India in order to obtain complete copies of the rules of Buddhist discipline. The pilgrims travelled to Yarkand, thence over the high mountain ranges, *via* Chitral to Jellalabad, Swat, the Peshawar valley, Tirah, Kurram, Bannu, and thence on to India. Their diaries give full contemporary information of the country with which we are dealing here. Everywhere they found the Buddhist religion in full force, the language of "Middle India," as they express it, prevalent, a dense population, peace and prosperity. Peshawar by that time had become a large city; close to it was the site of an immense monument, erected as a shrine over relics of Buddha, about 400 years previously by Kanishka the King, one of the successors of the Greeks. The pilgrim who describes it says: "The height of it was 470 feet and it was decorated with every sort of precious substance, so that all who passed by and saw the great beauty and graceful proportions of the tower and the temple attached to it exclaimed in delight, 'these are incomparable for beauty.' At sunrise the gilded discs of the vane on its summit are lit up with dazzling glory, while the breeze of the morning causes the precious bells that are suspended from the top to tinkle with a pleasing sound." Here, too, was the alms bowl of Buddha, of which the pilgrim records that the poor could fill it with offerings of flowers but not the rich. They mention also the gigantic tree associated with Buddha, which that insatiable sightseer, Baber, immediately went to see on his first visit to Peshawar in 1509. They

speak of an extensive monastery at the same place holding 700 inmates; this, too, then in ruins, was explored at much personal discomfort by Baber. All these have long ago disappeared, but it is a most interesting fact that, working on the diaries of the pilgrims, the head of the provincial Archæological Department, two years ago, discovered the actual precious relics. They rested in a cylindrical casket, 5 inches in diameter and 4½ inches in height, made of copper alloy, within which was a six-sided reliquary of crystal, 2½ inches by 1½ inches, having on one side a small hollow an inch in depth which had been sealed with the royal seal of Kanishka, bearing the device of an elephant. In this hollow were three small fragments of bone, which were believed by the builder of the monumental shrine to be relics of Gautama Buddha, and were undoubtedly deposited by him at this spot. The casket is ornamented in high relief with figures of Buddha, and portrait figures of King Kanishka with his attendants; other decorations in low relief are a long undulating garland of flowers upheld by little boys, and above it a highly ornamental band of swans flying with wreaths in their bills; these are beautifully modelled. Though the casket shows signs of artistic decadence, the influence of Greek art is manifest. To complete the interest of the discovery, the casket among its four votive or dedicative inscriptions bears the name of the Greek engineer who superintended the erection of the great monument.

By the seventh century Buddhism was fast on the decline, and in the ninth century Hinduism had re-established itself. In the next, or tenth, century begins the time of the Mohammedans. Ibn Haukal, who about 950 A.D. compiled a geographical account of the Mussulman world as then known, remarks that north and east of Sistan (then in Mohammedan occupation) lay Hindustan, meaning the country of the Hindus. From other sources it is known that Cabul was then a Hindu dependency. He mentions the Baluchis, but not the Afghans or Pathans; evidently the latter had not yet been converted to Islam. Towards the close of the tenth century a band of Turkish, Mussulman, adventurers from Central Asia seized Ghazni, and founded a principality which, under Mahmud and his successors, was to batter down Hindu opposition to the extension of Islam and to lead the way to the occupation of Northern India by various dynasties, some of Turkish, others of Afghan, origin, till with Baber rose the Moghul empire. The first mention of the Afghan race is met with in the eleventh century in the works of the Arab traveller, Alberuni. He visited India about the year 1010, and writes: "In the western frontier mountains of India there live various tribes of the Afghans; they extend as far as the land of Sindh, rebellious and savage races, people akin to the Hindus." About 1350 Ibn Batuta, another Arab geographer, notes that "Cabul was formerly an important city, but is now a village inhabited by Afghans. They hold the mountains and defiles and enjoy considerable power; the majority are brigands." He writes feelingly, seeing that the caravan which he accompanied was attacked by them. Attaching themselves to the Mohammedan invaders, the Afghans had become converted to Islam, and spread to the north and east, filling up the gaps due to the expulsion or migration of the Hindu population between 1000 and 1300 A.D. In the fifteenth century they were in considerable force round about Cabul, whence about 1460 A.D. a large body moved eastwards and commenced to occupy Peshawar and the adjacent valleys of Swat, Dir, and Bajour. In 1505 Baber speaks of Afghans in Kohat and Bannu, and near Peshawar, but in 1519 he found the bulk of the population in Bajour still non-Mohammedan. The troubles that followed his death gave the Afghans opportunities for further conquests, and, after the convulsions that attended the extirpation of the Roshaniya heresy in Akbar's reign, the main tribes finally settled down to the positions in which we still find them. This heresy is a peculiar incident in the local history. A Peshawar mullah who had wandered to Persia, Kurdistan and Asia Minor, set himself up as a religious authority at Peshawar about the middle of the sixteenth century, with the appellation of "Pir Roshan," or "shining spiritual guide." He abolished the Koran and preached a very advanced socialism. His doctrine spread among the tribes like wildfire. At one time he held Peshawar itself, and it was only after several religious wars had been waged by the faithful, with the aid of Imperial armies, that the heresy was extinguished with great slaughter. The struggle lasted for many years, during which the Afridis seized upon Tirah. This move was the last of the great tribal migrations.

What remains to be told of frontier history can be compressed into a few sentences. The administration of the Moghul, and after them of the Afghan, dynasty seems to have been tolerable, judged by an Oriental standard. The people were left to their devices so long as the general

peace was not broken; they held their own as well as they could against the hillmen, who had sufficient land at that time in their recently-acquired possessions, and did not feel the pressure of a growing population so much as they do now. Moreover, their surplus obtained ready service with a co-religionist Government. In spite of occasional disastrous collisions, things went fairly well. All this changed when the Sikhs supplanted the Afghan administration; there was naturally no sympathy whatever between governors and governed; the Sikh revenue system was as oppressive as it well could be; their draconic methods utterly failed to preserve order; and the hillmen who could, of course, no longer take service, fell to harrying the unfortunate country in the hated occupation of the Sikhs, who, in their turn, looked upon the former as a race under all circumstances for extermination, and sent them to the gallows upon apprehension. In the Peshawar district one chief actually held a grant from the Sikhs on the condition that he should annually produce twenty Afridi heads! Moorcroft, who passed through the district in 1824, notes that even Kashmir, miserable as it was, was not so desolate as the vicinity of Peshawar. Edwardes, writing in 1847, says that every two or three years the Sikh army harried the fields of the Bannu people, trod down their harvests, burnt their houses, and inflicted injuries which it took years to repair. In most parts of the Peshawar district the land taxes were collected by the periodical despatch of brigades. The Sikhs, in short, stood in the enemy's country, and acted accordingly. After thirty years of this veiled war we took over the frontier in 1849. The inheritance of misgovernment and maladministration was a serious one; it was comparatively easy to create order in the plains, but with the hillmen it was a different task, and it has taken fifty-six military expeditions to help towards that end. Although fifty-six expeditions in almost the same number of years sounds hopeless, an analysis of the figures shows improvement of late; in the first thirty years there were forty expeditions, but only sixteen in the second thirty years, and since 1901 there have been but two, each of the shortest duration—"week-end wars." It would be sanguine to build too confident hopes upon these facts; nevertheless there is some reason to conclude, as will appear later on, that the patient and steady work of sixty years has not been without results; the seeds of civilisation are germinating on the very stony soil on which they have to be cast. For the rest, the story of the five districts since annexation is one of peaceful progress; the population was exceptionally loyal during the Mutiny, and has been entirely untouched by the recent movements elsewhere.

Much has been debated concerning the alleged Jewish origin of the Afghans. On the one hand there is the strong tradition, which is universally accepted by the Afghans themselves; usually in such cases there is some, if only a slight, foundation for the popular belief. There is, too, the very unusual vitality of the Jewish race. On the other hand, everything else denotes the Afghans to be of Aryan descent. For many centuries they must have wandered, a pastoral race, in tents of black blankets, over the great barren plains and sterile ranges that lie between India and the fertile regions of Sistan and Candahar. It is quite possible that the Lost Ten Tribes were planted among, or found their way to, this race of nomads and were absorbed in them. When the irresistible Arab hosts advanced, a dim tradition of a Jewish element may have been revived and expanded to give to all Afghans, as such, a Semitic origin, and thus to place them more on a level with Semitic conquerors than were the Hindus. However that may be, I think there can be no doubt that the stock of the Afghans is homogeneous and Aryan. To the west they have been known always as Afghans—what that means no one knows; towards India they have always been called Pathans, from the generic name which they all use themselves when speaking their national language, viz., "Pakhtana" in the plural, and "Pakhtun" in the singular. The equivalent of "Pakhtana" is "Pathan" in Indian languages that are without the hard "kh." Theoretically, all Afghans are descended from a common ancestor, and ingenious attempts are made by their genealogists to dovetail into the national pedigree incorporated tribes and clans whose Afghan origin is, to say the least of it, doubtful. This is only the extension to the nation of the clan system, the essence of which is the actual or firmly-accepted traditional descent from a joint ancestor. How this acts in the tenure of land has been explained. It would be a mistake to suppose that this common relationship makes for concord—on the contrary, the character of the race and that terrible disintegrator, the blood-feud, keeps the clans ever disunited except under great pressure. Section is pitted against section; family wars on family; quarrels blaze up fitfully, die away, and are suddenly revived. In British territory,

of course, peace is kept; but the private vendetta flourishes as much as it dare. Briefly, the blood-feud is a debtor and creditor account of lives; blood demands blood. In theory, a murder can be compounded by payment to the injured, but since a composition is practically a confession of weakness it is seldom resorted to. One would think this state of things would be intolerable—to be shot, for instance, on account of what one's second cousin had done long ago; but a Pathan gives life as recklessly as he takes it. A feud is a source of pride, and an inexorable code of honour binds them in its iron grip. The necessity of exacting full revenge by retaliation is the evil of this code, its better side lies in the imposition of the equally sacred duties of an inviolable asylum to refugees; of the protection of dependents at all hazards; and of an open-handed hospitality. But this does not necessarily imply that you may not rob the stranger when once he has left your gates.

The civil constitution and the character of Pathans are obviously best seen in the natural state among the tribes of the hills; in the plains both have been much modified, a settled government has taken the place of self-government, and the character of the people has altered in some respects, partly to its advantage and partly to its disadvantage. The constitution of a Pathan tribe in the hills is the purest democracy; every adult clansman has equal political rights, and can, if he chooses, attend the tribal council in which is vested the power of the tribe or the tiny republic. Consequently, in important matters affecting large tribes, a council or jirga may be an unwieldy mob of up to 4,000 men. More usually, however, the tribe is content to let a smaller body act for it, and the jirga is composed of relatively few delegates, not representatives, who are selected by an informal process of popular choice. As the decisions of a jirga to take effect must be unanimous, it can be imagined what endless talk and discussion precedes a conclusion. But once they have made up their minds, the jirga, or rather the whole tribe, acts with great promptness. As against outsiders the jirga system operates fairly well. It is when we come to internal government that it breaks down. Theoretically the jirga should preserve general order and redress wrongs, but the latter only when appealed to, for every man has the right of private redress. As a matter of fact, the intestine factions and jealousies, the blood-feuds and incessant quarrels paralyse the power of the councils. It comes to this, that might is right and every man must look to himself, with the help of his nearest agnate relatives and such others as he can pay or persuade to join him. If he has no relations and friends he is in bad case indeed. It is, therefore, a source of congratulation to have many brothers, sons, and first cousins, second cousins are more doubtful; and the word to express a distant agnate relative is synonymous with enemy. Now put arms into the hands of every adult and one can realise the pandemonium—crime, violence and lawlessness are rampant within these republics. The wonder is not that offences occur on the border line, but that it is not always in a blaze. Of crime, in the Peshawar district, a British judge who knew it well, has written: "The principal crime with which we have to deal is murder—murder in all its phases; unblushing assassination in broad daylight before a crowd of witnesses; the carefully-planned secret murder of sleeping victims at dead of night, when often the wrong man is killed; murder by robbers; murder by rioters; murder by poisoners; by boys and even by women, sword in hand." Perhaps a rather highly-coloured picture, for, after all, in a population of over 800,000 souls, the annual number of murders is about one hundred. But it correctly depicts the condition of independent territory, where, moreover, the hired assassin flourishes. For £20 or £30 he will undertake to kill you any man; if he himself is killed red-handed the matter is at an end; if he escapes and names his employer, the blood-feud rests on the latter, and the agent is no more blamed than is his dagger. It is quite a reputable pursuit, and one at least of the profession, the well-known Chikkai, reached a high eminence of wealth and respect.

The character of the Pathan is a strange blend of virtues and vices—hardy, brave and proud; active in their habits and simple in their lives; frank, ready to die in obedience to their code of honour, yet often faithless and treacherous; generous to a degree and devoured by a greed for money; capable of great endurance and feats of energy, but constitutionally lazy; merry, cheerful, fond of music, sportsmen all, yet with a vein of sour austerity running through the nation. Envy of their fellows, instability of purpose, a suspicious temper, intense jealousy, bitter vindictiveness, excitability, and want of self-control are prominent faults. They are capable of strong personal attachments, and never forget a wrong. Grossly superstitious, credulous and bigoted, they know little of their religion, and will not permit their mullahs to interfere with their customs; but if danger

threatens from a foreign foe nothing is easier for the mullahs than to kindle a widespread fanaticism and to unite the clans under the leadership of the church. Impatience is a marked characteristic; Pathans understand and can take staggering blows, but nagging drives them mad. They highly appreciate justice, an open hand, firmness, patience, good humour, and the disposition that punishes and is friends again. They are great travellers and keen observers, shrewd men of business, good traders, indefatigable in the pursuit of gain, intellectually wide-awake, of active mental ability, and ambitious to a degree. The race is a mass of contradictions, which are accentuated by their strong individuality.

I have said that the border-land is a problem of surpassing interest and grave importance. A seething congeries of hungry clans had for generations been the terror of the peaceful cultivators in the plains, a border-line of hundreds of miles in extent had been exposed to their attacks when it fell to the British to tackle the problem. Slowly and patiently, but not without success, has that task been persevered in. We commenced by expeditions all round; the tribes unacquainted with our strength provoked coercion, and it was liberally applied, as was indeed necessary and advisable. At the same time, unconsciously following Roman precedents, clansmen were freely enlisted in the army, an outlet being thus provided for adventurous spirits and for some of the surplus population.

The next step came when in 1879–80 a body of tribesmen, now the Khyber Rifles, was formed by Government to keep order at their own homes. Presently it was recognised that the one thing, from a political point of view, to which the tribes are passionately attached and for which they will fight to the end, is their internal or domestic or municipal independence. It was also realised that although British laws and law courts, legal procedure, the police and revenue systems are excellent institutions in their proper places, it was not expedient to press them upon a people out of season. Accordingly, when Kurram was occupied in 1892, the Khyber experiment having proved a success, a local Militia was raised and the people were promised that they would be allowed to follow their own unwritten laws and manage their affairs themselves under the general superintendence of British officers, provided that the general peace was observed and British interests were respected. Subsequently, in Kurram, after the people had enjoyed general peace, and when they began to appreciate the comfort and attractions of security of life and property, a few British laws were applied to them, principally in the direction of the suppression of grave crime, at their own request. That is a very important point. When people ask for a thing they want it. Here again we were virtually proceeding on Roman lines—the Roman kept Roman laws, Roman rights and obligations, privileges to which the provincials might attain, as favours. In the other Agencies which have come into being after the Khyber and the Kurram valley were occupied, the same principles obtain; British supremacy is maintained by British officers, general order is enforced and British interests, including, of course, those of British subjects, are upheld, but otherwise the people are left alone. Insensibly they become accustomed to the benefits of tranquillity and order, almost without knowing it they are introduced to civilisation. I am sure that in this lies the solution of the problem; wherever in the border land we are compelled to hoist our flag, let it mean a general peace but not an interference with the self-government of the people. Once they are certain in their minds, and the difficulty is to convince them, that we have no intention of applying hated laws and detested systems, they welcome the general peace which saves them from collective disaster, and are glad enough to enjoy their own in their own way. At the same time the assumption of control brings with it the obligation of considering the material interests of the tribes. The chief question here is summed up in the one word—food. The population increases, not so fast as it might, owing to the diligent killing that goes on, but still it increases; land in the hills is limited, and what are the clans to do? Their native bent is towards robbery and raids. If this congenial means of livelihood is cut off, something else must take its place. As to this, enlistment in the army continues, and in addition the various corps of Militia and levies afford service to some 7,000 tribesmen. It has been explained what has been done for trade among them, and how facilities have been afforded for more peaceful migrations to India than were indulged in by the forebears of the borderers. And if in the areas about to be irrigated by the great canal projects now being undertaken or considered in the Punjab and Sindh, portions can be reserved for the hillmen, a step will have been taken with far-reaching consequences towards the pacification of the border. Doubtless there are difficulties in the way but we have surmounted worse in India, and have been the better for it.

It may seem rash to say, when we frequently hear of offences and sometimes of expeditions on the border, that a change for the better is coming, but the symptoms are unmistakable. The record of military expeditions shows that the use of force is more rare. This is significant, though too much reliance cannot be placed upon it, since in view of the recent arming of the tribes, we may have at any moment to re-assert our strength. But other indications of the change are plain. Thirty years ago the Black Mountain tribes were a perennial source of trouble; now the border of Hazara is the most peaceable section of the frontier. The Gaduns, the colony of Hindustanis, Buner, and the other tribes on the right bank of the Indus were a constant anxiety to the authorities at Peshawar. Lately these tribes took an eminent archæologist into the heart of their country in quest of Alexander's Aornos (which everyone will agree with him was not on the Indus, and probably lay in Swat). Who that fought on the Malakand in 1897 could have dreamt that drills worked by electricity would soon be boring a tunnel under the battle-ground, and that within fourteen years of a fierce rising of fanatics the chiefs of Lower Swat would be subscribing towards the establishment of a Lady Minto Female Hospital in their midst? Officers with small escorts travel in perfect safety to Chitral and back, where fifteen years ago such an attempt would have been certain death. In the Khyber an alternative road has been made by tribal labour alone. Up and down the frontier the most exposed positions are held by Militias drawn from the tribes themselves. A very notable instance of this change is that of the Kohat Pass; at either end of it lie the important garrisons and civil headquarters of Peshawar and Kohat, which obviously should be connected by a metalled road. Time and again, attempts to construct this road were baffled by the stubborn opposition of the tribesmen. They thought if the road came that their internal independence would go. Some years ago the case was put to them again; an officer whom they trusted implicitly—and Pathans are specially susceptible to personal influence—was able to convince them that this would not be the case; they accepted the road, helped to make it, and where formerly one had to pick one's way on horseback over the boulders of a torrent bed, one motors now in a couple of hours from Peshawar to Kohat.

It may be optimism: I can only tell you what in the course of thirty years I have seen myself, and that induces me to say that there is no ground for discouragement. Our aims should be to remove deep-seated suspicions, to punish thoroughly where deserved, then resume friendly relations, patiently persevere, and, above all things, civilise; we shall thus in the end solve the problem and succeed in the accomplishment of our task.

DISCUSSION.

The CHAIRMAN said he was sure all had listened with the deepest interest to Mr. Merk's paper. No one was better qualified to tell the story of the North-West Frontier Province. He had referred to the romance of the frontier, and its great attractions, and to the splendid names which had been connected with its history. Wild and sterile as the country was, it certainly had a charm which must appeal to everyone who had any spirit of adventure in his composition. It was the field of opportunities for young soldiers and young political officers; and his lordship could assure his hearers that many such were now gaining laurels which were unknown in this country, but which would be brilliantly recorded in history. Mr. Merk had alluded to the great advance in civilisation which had taken place generally on the frontier. He (Lord Minto) went out, in 1878, to join Lord Roberts. The railway then went only as far as Jhelum, and it was necessary to proceed, by long tonga drives and long marches, across the Indus, and on to Kohat, and then, by rough roads very open to attack, to Thul and up the Kurram. But when there the other day his lordship found the railway to Thul, and an excellent road to Parachinar, and the country looking full of prosperity. Moreover, the party came back in one day in motors from Parachinar to Kohat, and over the Kohat Pass to Peshawar. That was a marvellous change to those who knew the country thirty years ago. At the latter date one rode through the Kohat Pass at some little risk, but now one drove through comfortably in a motor. There is now a small factory of arms in the Pass, and on his recent journey one of the motors broke down, and in a few moments there appeared from this factory men who seemed fully acquainted with motor machinery. The same kind of change was seen on the other side of Peshawar. Not long after his arrival in India, his lordship visited the Swat Valley, and the only request made to him by the tribes was for the doubling of the railway line to Dargai, as the present haulage power was insufficient. The civilising power of railways was simply enormous; one saw it on all sides. Some people were nervous about the increase of railways, on the assumption that they might mean unjustifiable advance. But his own opinion was that railways would diminish the number of expeditions beyond all expectation. They brought people into touch with one another; they enabled the frontier tribes

to know us and trust us. Mr. Merk said the Pathan has commercial tastes, and knows very well what improved transport means, and that it would put more money into his pocket. It was working on the right lines to develop the railways not in a strategical, but in a commercial sense; they would exert greater civilising influence than anything else. Civilisation was bound to advance, and it would do so more quickly by commerce than by arms. Though we were yet a long way from the Durand frontier, he supposed that as years went on British administration would probably extend to it, and he hoped that would be feasible without innumerable expeditions; because, though he was very far from saying that expeditions were all over, they had certainly largely diminished, and the chances were that they would diminish more in the future. Mr. Merk alluded not only to better means of communication with regard to railways, but to the circulation of news which had taken place on the frontier; and that, his lordship thought, was having a very great effect. The tribesmen get news of all that is going on in India. In the Swat Valley he was talking to an old warrior who fought against us in 1897, who said, "I have been reading the papers, and I see you have trouble in Bengal." His lordship said, "Yes, there is a little trouble there"; to which the tribesman rejoined, "Why don't you send me and 400 men there? I would soon put it all right." He feared the treatment might have been a little crude. Still it showed how news was being circulated. The Amir got his Reuter's telegrams as regularly as did any official in India. On the whole the circulation of information was telling in the right direction. There was, however, another side to the picture. The enormous increase of arms was a disagreeable factor we could not ignore, though he agreed with Mr. Merk that it required special circumstances to unite the frontier tribes. They were much better armed now than in 1897; they possessed many more arms of precision; and if a common cause were to unite the tribesmen the danger to us would be greater than it was a few years ago. But the advance of civilisation had gained the upper hand, and he regarded the future as decidedly hopeful. The development of canals was also offering enormous opportunities. No one had realised the situation more than had Mr. Merk, particularly on the Bannu frontier, where the Mahsuds, who were not easy people to manage, had depended largely on plunder, and if that plunder was rendered impossible by the excellence of our administration what were these poor people to live on? If we could give them irrigated lands and increase their service in the Army, we should be going a long way towards solving the difficulty. In the Swat Valley the boring through the Malakand Pass, and the consequent development, not only of irrigation, but of vast electrical power was a marvellous feat of engineering. He thought this country should be proud of all that was going on on the North-West Frontier, and he regarded the future as full of promise. In conclusion, he could not say how grateful we should be to our frontier officers, of whom Mr. Merk was a brilliant representative.

The Right Hon. Sir MORTIMER DURAND, G.C.M.G., said he would take the hint given by Lord Minto to intending speakers, and be brief in his remarks. But, as he had been called upon, there were a few words he would like to say with regard to the interesting and very encouraging paper given by his old friend, Mr. Merk. He regarded it as very encouraging because he had seen Mr. Merk's work on the frontier, and knew how well fitted Mr. Merk was to tell us what was the real condition of affairs. The point which he (Sir Mortimer) wished to bring out was this, that the peace and prosperity of the North-West Frontier was not only a good thing from a local point of view, but concerned the very much more important question of Imperial defence. He had no desire to criticise recent conventions, or to express distrust of friendly nations. Nevertheless, it should be remembered that the security of India must always depend, not upon any agreements with foreign Powers, but upon our being so strong that no one would care to attack us. And nothing would add more to our strength than a thoroughly pacified borderland, organised for defence. Mr. Merk had shown that our frontier policy, slowly evolved from many conflicting policies, was proving successful, and that the borderland was in fact being pacified, and brought under effective control. There was, therefore, good reason to hope that, although we must still expect occasional trouble from the tribes, the belt of rugged mountain territory on our North-West Frontier would eventually be not a source of anxiety but a great barrier against aggression, a substantial addition to the security of India. That was the chief value of Mr. Merk's paper, and that was why he had listened to it with so much pleasure.

Sir THOMAS HOLDICH, K.C.M.G., K.C.I.E., C.B., congratulated the author on his lucid account of the frontier. One could not have a better authority on any matters connected with the frontier touching things commercial or judicial, or even criminal — in fact, he might say, especially criminal. For he remembered, many years ago, when he was with Mr. Merk at Peshawar, that the walls of his bungalow were decorated with a very gruesome array of murderers' knives; and if those knives were not actually dripping with gore, they were suspiciously unclean. They bore testimony to the flourishing condition of that particular branch of Pathan industry. With regard to the statement that the Afghans were of Jewish origin, that required a word of explanation; for if one addressed the Semitic Afghans with the statement that they were descended from Jews there would be trouble, for they hated and despised the Jew as much as their ancestors, the Israelites, did. Many arguments might be adduced on both sides, but so far as he knew the Durani Afghan had some

right to the claim to be descended from the Children of Israel. The name Afghan was Armenian, signifying simply a man of the hills, and that gave the clue at once to the tradition, inasmuch as the Israelite tribes were carried captive by Sargon to Armenia. Another point which came out of the paper was the arming of the tribes on the frontier. Everyone agreed that the tribes were now much better armed than they were a few years ago. One asked why they wanted these arms, and where they got them from? He did not believe that in the councils of any of the tribes of the frontier there was any idea of a serious invasion of India. Those tribes had reasons of their own for wishing for arms. When he was working hand in hand with Mr. Merk, on the Oxus frontier, each of them was supplied with an orderly from the 11th Bengal Cavalry. These men lived together, ate together, served together, and were very handy assistants. On one occasion, one of them helped the other out of a river when he was in danger of being drowned. Yet when the expedition was over, and it was time to dismiss the men, his orderly came to him and asked for a rifle. On being asked why, he said: "Because Merk Sahib's orderly has acquired a valuable rifle, and we have got to settle matters between us now that the Commission is over. We are going to our own country, and one of us has got to shoot the other, and he has all the advantage on his side." He (Sir Thomas) told him he could not give him a rifle, but in the end he gave him his revolver, with the strict injunction that he should only use it in self-defence. He took it away, and nothing more was heard of him. Thirteen years afterwards he (the speaker) was in the man's country, and he enquired whether the people recollected him. They replied, "Yes, we remember him well. Twelve years ago he was shot by Merk Sahib's orderly." That was the truth of the position. Just as we in England wanted more "Dreadnoughts" and more arms to assert our position in the councils of the European nations, so did the tribes in the hills require a similar power of asserting themselves. Rifles were turned out in thousands in the factory of the Amir of Afghanistan, but they were for his own people; he (the speaker) never saw Afghan rifles on the frontier. Occasionally they were stolen from our people and carried across the frontier. There were times when one could purchase service ammunition across the border considerably cheaper than in India; but he thought those times had now gone. The chief source of supply was undoubtedly gun-running. With regard to the latter, Mr. Lovat Fraser had told us all about it. He showed that the trade was British, British in its inception, British in its continuance, though France, Belgium, and America had all cut in more or less. The trade was very lucrative, and whilst that was so it would be very difficult to stop it. There were still steamers plying in the Persian Gulf in connection with that trade. He would like to know Mr. Merk's opinion of how those rifles were paid for. Undoubtedly they were partly paid for by rupees furnished from the Indian Treasury in the form of subsidies. Thus we supplied arms at this end, and paid for those arms at the other end; and yet we came down heavily on the Arab sailors who ran their dhows across the Persian Gulf, and on the leaders of the Afghan caravans who conveyed those arms across the deserts of the Persian frontier. That created a position that was certainly illogical.

General Sir Alfred Gaselee, G.C.B., said he felt it a great privilege to bear testimony to the very able paper which had been read. The sentiments he had intended to express had been largely forestalled by Sir Mortimer Durand, and also partly by Sir Thomas Holdich. Mr. Merk said that we had 300,000 armed men, or men capable of bearing arms, men who were hardy, inured to warfare, and brave. Amongst themselves those men were without any definite control, and it had been said that they were not easily induced to take up arms in any quarrel of their own. But they had also heard that there had been, on the frontier, fifty-six expeditions—extending over, it was true, a good many years. Special mention was not made of the big expedition in 1897–8, when we had 50,000 troops mobilised. That was a very big affair, and if we had been occupied in any other part of the world at the same time it would have been a very serious matter indeed, and would have gone a long way towards crippling us. We had an experience of how brave and unorganised and undisciplined men could harass an army. That was before the days of the Boer War, which also taught us a great lesson. He was not an alarmist, but the situation on the frontier called for the earnest and careful thought of our statesmen and leaders. His impression was that the subject did not receive the attention it deserved. He did not believe that the Pathan bought his arms simply in order to shoot his neighbour, though that might be part of the reason. When it was remembered that nearly every man on the frontier was able to use a rifle, it showed that close watch and care should be observed.

Dr. M. A. Stein, in proposing a vote of thanks to the reader of the paper, said he considered it a great honour to do so, as Mr. Merk was a judge of unparalleled experience of the frontier. His (Dr. Stein's) studies drew his interest to the North-West Frontier long before he was able to go there, though that was twenty-two years ago; and though he had since been able to carry his travels and researches far beyond India, into Central Asia and China, he felt strongly drawn to the North-West Frontier, which was full of fascination to every historical student. He could not venture to touch on many points of history, as he feared he would detain the meeting far beyond the allotted time if he did; but one or two points had a direct bearing on the modern conditions with which they were that afternoon pre-eminently concerned. It was true that the North-West Frontier had always been the

gate of India, but it was all important on which side of that gate stood those whose function was to guard it. Nowadays this frontier and the tribes inhabiting it had to be watched with great care against the possibilities of invasion. Until the last century, that frontier had been really the advanced base for Powers which were not essentially Indian. Ever since the time of King Darius, when the frontier formed part of the Persian Empire, stretching down to the Mediterranean, this territory had been very closely linked in its history with Eastern Iran, and that fact was reflected by the population as it at present stood. It was not the result of chance migration. The Pathans, linguistically and anthropologically, were proved to be of Eastern Iranian stock. Mr. Merk, in his masterly survey, had not touched on the work done by recent administrators of that bulwark of India, and one could understand his feelings in the matter. But for one who had special opportunities for watching the work of frontier "Politicals" without yet sharing it, it was a privilege to be able to testify to the essential part which their personality has played in the success achieved by their administration. He (Dr. Stein) knew that the late Sir Harold Deane, that truly great "Warden of the Marches," had always been guided by a full appreciation of the past history of the frontier and of the ethnic features of its population. He hoped that these factors would always receive due recognition in future frontier policy.

Dr. Walter Saise said in reference to Mr. Merk's remarks on the connection of the Afghans with the Lost Ten Tribes of Israel it might be of interest to them to hear what the Amir of Afghanistan himself thought of the matter. When he (the speaker) was in Cabul, at the end of 1909, the Amir said to him, "Dr. Saise, take your notebook and write down what I say. We, the Ben-i-Israel, came to this country and conquered it. We converted some of the people to the faith of Israel; we killed some of the people; and others in the inaccessible mountains remained with their old religion. Cannot define that religion. Like that of the North American Indians. Went about troubling people; killing people! They were the Kaffirs. In the time of Osman the Arab (the fourth Caliph of Medina) Cabul was taken and we, the Ben-i-Israel, became Mussulmans. But we reverted to our Israelitish faith, and then in the time of Abdul Malik (the tenth Caliph), son of Merwan, and when Hoojaj was Governor of Iran (Persia), we were reconverted to Mohammedanism, and have retained the truth faith ever since." This would be about 700 A.D. That belief of the King of Afghanistan in his Israelitish origin was worth recording, even should it have small ethnographic value. He (Dr. Saise) was inclined himself, after a personal acquaintance with the Afghans, to consider there was much force in the reasoning of Sir Thomas Holdich—in that fascinating work, "The Gates of India"—that the Afghans are descendants of the Lost Ten Tribes of Israel. But be this as it may, he heard from the King's own lips that he believes he is descended from Israel, and all the Durani (the royal) tribes believe it also. Mr. Merk's reference to railways reminded him that his Afghan companions, among them the Mehmandar Bashi (a cousin of the Amir), on the way to Cabul, informed him that they did not like railways! They stated that before the railway came to Peshawar wheat flour sold at twenty-four seers per rupee. Now the price is six seers per rupee. "When you build railways," said they, "away go the food-stuffs to other countries and prices rise!" This view was held by most of the Afghans with whom he had conversation, and the subject was constantly cropping up, for he frequently reminded them he could get from Bombay to London by train and ships as quickly as they could travel from Peshawar to Cabul on ponies. He had great pleasure in seconding the vote of thanks to Mr. Merk for a most interesting and instructive paper.

Mr. Merk, in reply, said there was no doubt that the tribesmen were now better armed than formerly. They had increased their fighting strength in every respect save one, and that was the following: they have breech-loaders, and, unless they could manufacture their own ammunition, they would soon come to the end of their resources. But, apart from that, the arming of the tribes was a further reason for what he had suggested as the keynote of the policy which should be pursued, namely, to civilise. He expressed his keen appreciation of the vote of thanks, and for the interested attention of his audience.

Sir William Lee-Warner, G.C.S.I., Chairman of the Indian Section, in thanking Lord Minto for taking the chair, remarked that what his lordship had done in the five years of his rule, in a time of exceptional difficulty, history would record. All present felt great gratitude to Lord Minto for presiding so soon after his return home, and for the remarks he had made before a section which did its best to disseminate a knowledge concerning the great Indian Dependency.

The Chairman, in acknowledging the thanks, said it had been a great pleasure to be present to hear the admirable paper, which had been followed by an equally good discussion. He would always be glad to do anything he could to assist a discussion about Indian affairs, and to facilitate a better understanding of the Dependency among the people at home.

HOME INDUSTRIES.

State Insurance.—The debate on the second reading of the Insurance Bill has disclosed no ill feeling towards the measure, but some anxiety as to what might result from its becoming law in its present shape, and outside Parliament the anxiety is much more pronounced. Great interests are uneasy. At present employers of labour are not

loudly objecting—they are reassured by the experience of Germany—but it is significant that the resolution submitted to a conference of Friendly Societies for referring the Bill to a committee of inquiry, and which, as it originally stood, spoke favourably of the Bill, was amended so that it might be entirely neutral; the Trade Unions fear that the Bill may be prejudicial to them; the doctors, with whom it so largely rests whether the Bill, if it becomes law, is to work well, are holding great meetings of protest; and those who speak for the more helpless classes—the casual, the charwoman, the domestic servant, and the like—dwell upon the neglect of the Bill to give them adequate protection. The chief objections may be summarised as follows:—(1) The Bill is unjust, since the healthy and efficient will pay for the weakly and inefficient whilst receiving nothing, and women are barred when married; (2) there is inequality of sacrifice; (3) the classes most in need of assistance—the casual worker, the migratory worker, the small worker for no master—will be more or less outside the benefits of the Act; (4) unless the bill is amended, the remuneration offered to doctors will not attract competent men; (5) the effect on labour must sooner or later be unfavourable, since wages will be lowered, or staffs reduced, or prices raised; (6) a great impetus will be given to malingering, more especially simulated unemployment; (7) the Friendly Societies will be prejudicially affected by reduction of subscriptions, the managing committees and officers will be unable to do the work thrown upon them, and the risk of defalcations will be great, and will lead to State control that must affect the independence of the Societies; (8) doles of money emasculate, and there is grave risk that the scheme may revive some of the abuses of the old Poor Law system. These several objections to the Bill may be satisfactorily met, but one and all they are weighty, and will require exhaustive discussion in Parliament if the Bill is not to work more evil than it cures.

Textile Workers.—The General Secretary of the Amalgamated Society of Operative Cotton Spinners, who is also Secretary of the International Federation of Textile Workers' Associations—which meet in Amsterdam next month—has issued his annual report, which contains much interesting information as to the work of the organisation during the past three years. The secretaries of the English Trade Unions give particulars of the conditions in their own departments. Mr. Marsland, of the Operative Spinners' Association, gives figures which illustrate the difficulties passed through during the three years, 1908–10. The number of disputes dealt with at the central office was 487. To members out of work through bad trade and other causes the sum of £236,597 was paid. Members who had met with accidents in the mills were paid £17,067. The amount paid to members involved in strikes and lock-outs was £173,153. During the same period £2,041 was paid in grants to help other associations. The total expenditure for the three years amounted to £503,679. In many districts every spinner belongs to the Association, and where this is not the case the percentage of non-members is very small.

The Infliction of Fines, and Humidity in Mills.—The Secretary of the Northern Counties Weavers' Amalgamation reports that, taking the same three years, the total cost for strikes and stoppages of all kinds to the district Associations and the Amalgamation reached £276,346. For many years past there has been a system in the weaving department of inflicting fines for alleged bad work which has become so irksome that the workpeople have commenced an agitation for the abolition of all fines and deductions from their wages. There is also general complaint of the practice of about one-half of the weaving mills which use artificial humidity in order to make a "weaving atmosphere." Hot steam is sent into the sheds and ejected from pipes, or the air is sprayed with fine particles of water. The workpeople have taken strong objection to this practice, on the ground that it is detrimental to their health, and that it is mostly required in order to facilitate the weaving of inferior material. It seems that hot air is sent through the sheds even in the summer months, causing great personal discomfort and much physical prostration, and in the winter months the sheds are said to be heated to such an extent that many workpeople contract bronchitis and rheumatism. Some time ago the Government appointed a commission, which included representatives of the workpeople and employers, to inquire into the whole question. The inquiry extended over two years, and the report is expected in the course of the next few weeks.

The Northrop Loom.—Considerable apprehension is being felt by workers as to the progress of this loom. Its general adoption would bring the cotton weavers of Lancashire face to face with a very serious problem—perhaps the most serious they have had to reckon with in our time. Operatives are now working twelve, sixteen, and twenty Northrop looms each, and the number of looms of the Lancashire type worked by an operative does not average more than four for each weaver. It follows that the general adoption of the new loom would mean the displacement of a very large number of workpeople. It is not at all likely that the cotton trade will ever, even under the most favourable conditions, be able to expand sufficiently to absorb those thrown out of employment by the new loom, and it is not easy to find the solution of the problem.

The New Tulle Process.—A new process that is being worked at Fresnoy-le-Grand, near St. Quentin, bids fair to affect seriously the silk tulle industry. The new fabric is produced from the same raw material as artificial silk and dispenses with the weaving operators, the fabric being made directly from the ordinary artificial silk solution. The system is a modification of that of ordinary calico printing, but whereas in calico printing the object

is to transfer the colours from the engraving to the cloth, in the manufacture of tulle the printing paste is caused to coagulate in the engraving, and then removed from it as a continuous web. A large copper cylinder, much larger in circumference than the ordinary calico-printing roller, is engraved with a net pattern, so that if a piece of gauze or tulle or corresponding design were wrapped round it the fabric would fall into the engraved portion. A description of the process in *The Manchester Guardian* says:—"The printing 'colour' used, a fairly thick solution of viscose, cellulose in cupro-ammonium, or celluloid, in fact, the usual mixture used in the manufacture of artificial silk, is fed on to the roller from a trough arrangement fixed over it, not from a colour-box below it. The roller revolves slowly, and the surplus 'colour' is removed in the ordinary way by means of a 'doctor,' leaving the engraving filled with paste. This is then caused to coagulate whilst in the engraving by spraying the roller with some suitable solution—water for celluloid, zinc chloride for viscose, or dilute sulphuric acid for a cupro-ammonium solution of cellulose—the surplus liquor running off the cylinder into the trough beneath. The solidified artificial silk is then removed from the engraving in a similar manner to that adopted in the preparation of celluloid films, etc., and carried away as a continuous piece on an endless travelling band pressing against the cylinder. The engraving, after delivering its contents, is thoroughly cleaned by squirting it with water, and dried by means of a hot-air blast, and goes round to receive more 'colour,' the cyle of operations thus going on continuously. The French works has now thirty of these machines running, each capable of producing about fifty yards of tulle per hour. The cost of manufacture is said to be about three-halfpence per yard. The material is fairly strong, especially to tearing, and does not compare at all unfavourably with the ordinary woven goods. It is proposed to erect a works in Germany."

Bradford and Australia.—Mr. C. Hamilton Wilkes, who is His Majesty's Trade Commissioner for Australia, has expressed his surprise at the seeming apathy of Bradford. Mr. Wilkes has been paying visits to the chief commercial centres of the country. At Manchester and Sheffield he was welcomed, but at Bradford manufacturers and merchants, as he complains, ignored him. "The Bradford manufacturers," he says, "must be perfectly satisfied with the trade they do with Australia, as evidently they believe they know everything that is to be known about the conditions of trading in that vast continent." And yet, as Mr. Wilkes points out, the British imports of velvet and velveteens into Australia amounted in value last year to only £274,786 worth out of £1,094,262. Mr. Wilkes thinks there is something in this matter worth consideration by British manufacturers, but the Bradford Chamber of Commerce, when officially informed of Mr. Wilkes's intended visit, decided to take no action as a body, and many members expressed their opinion that Trade Commissioners can teach them nothing.

The Coronation and "Sweating."—Miss Emily Cox, who is chairman of the Manchester, Salford and District Women's Trades Union Council, expresses the fear that the Coronation preparations mean for some of the humbler workers sweated labour. Miss Cox says that a few days ago she found a Manchester handkerchief-hemmer at her machine, but the work on which she was engaged was not the usual long strips of handkerchiefs, but Coronation flags, and these flags are not paid for at the usual rates. Handkerchief-hemmers are among the worst paid of the home-workers of Manchester, but for this special work a still lower depth of sweating has been reached. Small flags are machined for less than 5*d.* a gross. For flags a yard long (two sides only to be hemmed) the machinist is paid 7½*d.* a gross, and out of this she has to supply cotton, which costs over 2*d.* for the one hundred and forty-four flags. Thus for two hundred and eighty-eight yards of machining, and for the finishing, folding, and carrying to and fro, she receives about 5½*d.*, and she must work on Sundays as well as week days to earn enough for her rent, and the ever-shrinking pittance that goes for food.

OBITUARY.

Sir Charles Alfred Elliott, K.C.S.I., LL.D.—Sir Charles Alfred Elliott died suddenly, from syncope, on the 28th May, while he was attending communion service at St. Paul's Church, Wimbledon Park. Born in 1835, he was educated at Harrow and Trinity College, Cambridge. In 1856 he passed into the Indian Civil Service, and served through the Mutiny in 1857–8, receiving a medal and being mentioned in despatches. After holding several minor offices he was appointed Secretary to the Government of the North-West Provinces, a post which he held from 1870–5. In 1877 he became Famine Commissioner in Mysore, and in the next year Secretary to the Famine Commission presided over by General Sir Richard Strachey. He was then selected to organise the Census of 1881, but before this task was completed he was appointed Chief Commissioner of Assam. From 1886–7 he was President of the Finance Committee, from 1887–90 Member of the Executive Council of the Viceroy in charge of Public Works, and from 1891–5 Lieutenant-Governor of Bengal. After his return to England he served on the London School Board, and as Chairman of its Finance Committee up to the time of its abolition by the Act of 1902. He was created K.C.S.I. in 1886, and LL.D. of the University of Edinburgh.

Sir Charles became a member of the Royal Society of Arts in 1896. In the following year he read before the Indian Section a paper "On Measures taken by Government for the Prevention of Famine in India," for which he received a silver

medal; and in 1905 he read a second paper on "The Indian Census Report, 1901." He presided at a meeting of the Indian Section in 1907, when Sir Edward Buck, K.C.S.I., read a paper on "The Applicability to India of the Italian Method of Utilising Silt," and he took part in discussions on numerous occasions. He was a member of the Indian Section Committee, and he made his last appearance at the Society only three days before his death, when he was present to hear the paper which is reported in this number of the *Journal*.

GENERAL NOTES.

PRIZE FOR ELECTRIC LAMPS FOR MINERS.—The sum of £1,000 has been placed by a colliery proprietor at the disposal of the Secretary of State for the Home Department to be offered as a prize for the safest and most efficient electric lamp or lamps for miners. The competition is open to persons of any nationality, and the lamps submitted must reach the Home Office Testing Station, Rotherham, not later than December 31st, 1911. Particulars of the requirements which the lamps must fulfil may be obtained at the Home Office. In judging the competition, regard will be paid to (*a*) the first cost of the lamp; (*b*) the cost of maintenance; (*c*) convenience in handling; and (*d*) he weight of the lamp when charged and ready for use.

THE QUEENSLAND SUGAR INDUSTRY.—Queensland is one of the great sugar-producing States of Australia, and practically all of the sugar consumed in the Commonwealth is grown and refined in this State and in the northern part of New South Wales. The leading feature of the industry is the number of small cane-growers engaged in it, who now supply cane to the central mills, of which they are proprietors, as compared with the large estate owners of the past. There are about 125,000 acres of land in Queensland under sugar cane. The estimate of the output of sugar for 1910 was 170,684 tons produced by white labour, and 15,492 tons produced by black labour. There are fifty-three sugar factories in operation in Queensland, employing over 4,300 hands and representing an investment of about £2,250,000. The chief enemies of the sugar cane are the cane grub north of the Tropic of Capricorn, and frosts in the south, also occasional fires.

NEW PORT AT BUENOS AYRES.—The Government of the Argentine Republic have decided to construct a new port at Buenos Ayres. The cost of this undertaking is estimated at 24 millions of piastres (paper currency).

THE FRENCH MATCH MONOPOLY.—The annual report of the Director-General of the State Manufactories in France, which has recently appeared, shows that the total receipts of the match monopoly in 1909 amounted to £1,600,000, an increase of £16,000 over the preceding year. The net profits were £14,600 in excess of the profits realised in 1908. The average consumption of matches per caput in France during 1909 was 1,146, representing an expenditure of a fraction over elevenpence. The ordinary wooden sulphur matches, which ignite by friction upon any surface, furnished 55·6 per cent. of the quantity delivered to the public; wooden safety matches, which ignite upon a special surface, 41·2 per cent., and wax matches, 3·2 per cent. The State purchased during the year £71,500 worth of foreign matches to supplement its own production. Employment was given to 834 men and 1,467 women, distributed among the six State factories, which are situated at Marseilles, Pantin-Aubervilliers, Trélazé (Maine-et-Loire), Aix-en-Provence, Saintines (Oise), and Bègles (Gironde).

MEETINGS FOR THE ENSUING WEEK.

TUESDAY, JUNE 6...Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. W. Watts, "Charnwood Forest and its Fossil Landscape."
Photographic, 35, Russell-square, W.C., 8 p.m. Mr. Demachy, "The Oil-Transfer Process."

WEDNESDAY, JUNE 7...Economics and Political Science, London School of, Clare Market, W.C., 5 p.m. Professor Sir John Macdonell, "The History of International Law since 1848."
Concrete Institute, 296, Vauxhall-bridge-road, S.W., 11.30 a.m. Summer Meeting. 1. Professor Beresford Pite, "The Aesthetic Treatment of Concrete." 2. Report of Committee on "The Testing of Concrete, Reinforced-Concrete, and Materials Employed Therein."

THURSDAY, JUNE 8...Concrete Institute, 296, Vauxhall-bridge-road, S.W., 11.30 a.m. Summer Meeting continued. 1. Mr. A. E. Corbett, "The Y.M.C.A. Building, Manchester." 2. Report of Committee on "The Standardisation of Drawings of Reinforced-Concrete Work."
Royal Institution, Albemarle-street, W., 3 p.m. Mr. T. Thorne Baker, "Practical Progress in Wireless Telegraphy."
Optical, at the Chemical Society, Burlington House, W., 8 p.m. 1. Dr. Ettles, "Sight Testing Apparatus." 2. Mr. S. D. Chalmers, "Zone Plates." 3. Mr. V. H. Mackinney, "A New Toric Machine."
Aeronautical, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m.

FRIDAY, JUNE 9...Royal Institution, Albemarle-street, W., 9 p.m. Professor Svante Arrhenius, "Applications of Physical Chemistry to the Doctrine of Immunity."
Malacological, Burlington House, W., 8 p.m. 1. Mr. E. A. Smith, "Description of a New Species of Acmæa from Bombay and Notes on Other Forms from that Locality." 2. Mr. H. B. Preston, "Description of Three New Species of Operculte Land Shells from Grand Cayman Islands." 3. Mr. G. K. Gude, "Further Note on Preoccupied Molluscan Generic Names and Proposed New Names."
Geologists' Association, University College, W.C., 8 p.m. 1. Dr. Carl Fred Kolderup, "The Geology of the District of the Bergen Arches." 2. Mr. Horace W. Monckton, "The Rock Formation of the Bergen District."

SATURDAY, JUNE 10...Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. L. Courtney, "Types of Greek Women." (Lecture II.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

THE ROYAL SOCIETY OF ARTS.*

By Sir Henry Trueman Wood, M.A.,
Secretary of the Society.

I.—The Origin of the Society.

During the eighteenth century several societies were established in different parts of the three kingdoms for the encouragement of the Arts and Industries. The oldest of these is the Royal Society of Dublin. This was founded in 1731, under the title of the Dublin Society for Improving Husbandry, Manufactures and other Useful Arts. Previous to this, in 1683, a Philosophical Society, on the model of the Royal Society of London, had been formed. This had rather a chequered existence, and seems to have come to an end before the close of the seventeenth century. Later on the second Dublin Society was established, mainly by Dr. S. Madden, who himself provided prizes for useful inventions and for proficiency in the Fine Arts.

In 1749 this Society was incorporated under the name of the Royal Dublin Society, in which name it has ever since carried on much valuable work. It had the advantage of Government aid, and between 1761 and 1767 it distributed Government grants to the amount of £42,000 in the promotion of agriculture and manufactures.

* Nothing like a history of the Society has ever been written. A great deal of information is contained in a lengthy paper read in 1868 (see *Journal*, Vol. XVII. p. 10, etc.), by S. T Davenport, who was Financial Officer of the Society from 1853 till his death in 1875. The best account of the Society is to be found in a series of articles contributed to *Engineering* in July and August, 1891, by H. B. Wheatley (Assistant Secretary 1879 to 1909). A short but brightly-written sketch of the Society is given in "Scientific London" (B. H. Becker), 1874. The "Microcosm of London," published by R. Ackerman in 1811, gives a good account of the Society as it existed at that date, and contains an interesting picture of the Great Room, showing the arrangement of the room before the modern alterations. Charles Knight's "London," Vol. V. (1843) also contains an illustrated chapter on the Society. Some other accounts might be mentioned, but on the whole, outside of its own publications, the history of the Society must be sought in the magazines and newspapers of the last two centuries, from the *Gentleman's Magazine* and the *Public Advertiser* down to the periodicals and journals of our own time.

The London Society of Arts, therefore, dating as it does from 1754, though the oldest association of the sort in Great Britain, is younger by some twenty-three years than the sister society in Ireland.

Two other technical societies founded in the eighteenth century still survive, the Highland and Agricultural Society of Scotland (1784) and the Bath and West of England Agricultural Society (1774).

In America, before the foundation of the Society of Arts, Dr. Franklin had already published (1743) a "Proposal for Promoting Useful Knowledge Among the British Plantations," and this led to the formation of the American Philosophical Society, which still flourishes, but devotes itself exclusively to pure science. In 1765, after the establishment of the Society of Arts, a similar society was formed in New York, and a number of prizes were offered for industrial advances in the Province of New York. The first list of such prizes, which varied in amounts from £30 to £2, was sent to the London Society, and is still in existence. Many other societies, some of an industrial character, were started in America later, after the independence of the United States.

All the other technical societies established about this time had but a brief existence, and few of them have left any records behind them. Lecky* mentions a Society for Improving the Knowledge of Agriculture in Scotland as established in 1723. In 1754 there was founded the Select Society of Edinburgh for encouraging the Arts and Manufactures of Scotland. The principal promoter of this was Elizabeth, Duchess of Hamilton—one of the beautiful Miss Gunnings. Mrs. Palliser refers to this society in her history of lace, and mentions the award of prizes for Scottish lace for some few years. At one time this institution was in correspondence with the Society of Arts in London.

* "England in the Eighteenth Century," Vol. II., p. 318 (Edition 1909).

Perhaps the most curious of these institutions was the Anti-Gallican Society, which was established in London in 1750 or 1751, for the protection of native industries and the discouragement of French imports. This society seems, by reports which appeared from time to time in the *Gentleman's Magazine*, to have held quarterly meetings up to 1754, or thereabouts, at which meetings small prizes were awarded for English lace, needlework, etc. In 1753 a medal was presented to one Captain John Mead, "for having caught the greatest number of whales last season"; and another medal to Captain Cockburne "for his gallant behaviour to the commander of the French squadron at Annamobar, on the coast of Guinea." On another occasion they made a grant of five guineas to "an honest, industrious old couple" whose cow had died from "the distemper." For some time there is no further available information about their proceedings; but in 1759 they appear to have taken more strenuous action by starting the "Anti-Gallican" privateer. This ship captured a French Indiaman in Spanish waters, whence arose considerable difficulty; eventually the prize was declared illegal, and had to be given up. It looks as if this last effort in the promotion of British industries brought this Society to an end, for no further record of their proceedings appears.

There may have been other precursors of the Society of Arts, but research has failed to find evidence of their existence. After the Society was founded it had a certain number of imitators. The *Gentleman's Magazine* for 1755, p. 505, contains an account of a society established that year in Breconshire on the model of the Society of Arts, for the encouragement of local agriculture and manufactures by the offer of prizes, and the suggestion is put forward that other like societies might usefully be established in all the counties. After 1768, when, as hereafter mentioned, Shipley, the Society's founder, had retired to Maidstone, he founded a local society there which for some years did useful work.

Archdeacon Cunningham, in his well-known work,* mentions in his list of authorities "An Account of the Origin, Proceedings and Intentions of the Society for the Promotion of Industry in the Southern District of the parts of Lindsey in the county of Lincoln, 1789," but up to the present no further information about this institution has been discovered. A Society of Arts was established in Barbados in 1781, and continued to publish proceedings till 1784. These publications are mentioned in the supplement to Cundall's "Supplement to Biographia Jamaicensis," and copies are in the British Museum Library.

On the Continent the Society had at least one direct imitator, for it is recorded that the Empress Catharine II. of Russia was so much pleased with the account of the premiums offered by the Society of Arts, that in 1766 she established in her own dominions the Free Economical Society of St. Petersburg, with objects similar to those of the English Society.

Later on there were many societies founded, both at home and abroad, with similar objects to those of the Society of Arts, but all these were started after 1800. The closing years of the eighteenth century saw many more scientific, philosophical, and literary institutions founded, but none of these were of the same character as, or had similar aims or objects with, the Society of Arts.

The earliest proposal of which any record exists for the foundation of a Society of Arts in London goes as far back as 1721, when it is said that a pamphlet was published, entitled, "Three Letters concerning the forming of a Society to be called the Chamber of Arts, for the preserving of Operative Knowledge, Mechanical Arts, Inventions and Manufactures."* Probably the time of the South Sea Bubble was not a fortunate one for the exploitation of such schemes; certainly nothing came of the proposal.

In 1753 William Shipley † published in Northampton certain "proposals for raising by subscription a fund to be distributed in premiums for the promoting of improvements in the liberal arts and sciences, manufactures, etc." This was followed a little later in the same year by "a scheme for putting the proposals into execution," published in London.

* "English Industry and Commerce," Vol. II., p. 993 (Edition 1907).

* "Short Account of . . . the Society," etc., by a member (Edward Bridgen), 1765. A scarce pamphlet, giving an account of the Society of Arts' origin.

Another rather similar pamphlet, "A Concise Account . . . of the Society," was published two years earlier, in 1763. It also was anonymous, but was written by Thomas Mortimer. The information it contains is rather fuller.

† The materials for a life of Shipley are scanty. A certain amount of information is to be found in the Society's minute books and account books. The writer of the "Concise Account of the Society" previously referred to, states that an account of Shipley's proceedings in connection with the foundation of the Society was drawn up, and a copy presented to "the Antiquarian Society," by James Theobald, one of the Society's first Vice-Presidents. No such document, however, either in print or MS., is now to be found in the library of the Society of Antiquaries. The author of

Shipley was a portrait and landscape painter of no great merit. According to Redgrave* he was "better known as the founder of the St. Martin's Lane Academy, known as Shipley's School, where the best artists of a whole generation studied." Where Redgrave got his information from is unknown. No evidence can be found to prove that Shipley's Academy was in St. Martin's Lane, though the Academy founded by Sir William Thornhill in the Piazza, Covent Garden, was transferred there after his death by his son-in-law, Hogarth. Later on, in 1763, we find that special prizes were awarded by the Society to the pupils in this school, and also to the pupils of the school † established by the Duke of Richmond in Whitehall.

Shipley's Academy was certainly in the Strand. Where it was before Shipley's connection with the Society it does not seem possible to say. It must have been in existence, because Richard Cosway received his earliest instruction at it, and Cosway was amongst the first prize-winners of the Society. Afterwards it seems to have migrated with the Society to the various houses in which the offices of the Society were during the first five years of its existence—Craig's Court, 1755; Castle Court, 1756;‡ and Little Denmark Court, 1759. After this, when Shipley's official connection with the Society had ceased, there seems some reason to believe that his Academy was moved to the house at the corner of Beaufort Buildings (afterwards No. 96, Strand), which later on became Ackerman's Fine Art Repository, and later still Rimmel's well-known perfumery shop. Beaufort Buildings disappeared about 1902–4, when the new Savoy Hotel buildings were erected, and the Strand frontage was set back.

Not very much is really known about Shipley's life. He is said to have been born in London in 1714.* His father was Jonathan Shipley, "Citizen and Stationer" of London. He was a native of Leeds, who afterwards lived in Walbrook. William's mother was Martha Davies. Her family owned Twyford House, near Winchester, and the property was inherited by Shipley's brother Jonathan, the Bishop of St. Asaph. He was a liberal-minded divine, a friend of Franklin's; and it was said, probably without truth, that he might have been appointed Archbishop of Canterbury but for his strongly-expressed opposition to the American War.

William Shipley is said to have been originally a drawing-master in Northampton, and to have settled in London in 1750, though it was from Northampton that he dated his "Proposals." He appears to have been an active-minded man, full of ideas, and with some capacity for organisation; but perhaps devoid of ambition, for he never seems to have troubled himself to obtain either credit or profit out of the successful realisation of his ideas. According to a Maidstone tradition he was an absent-minded man, so much so, that on his way to church to be married he was led away by the sight of a rare butterfly to start on its pursuit and, consequently, arrived late for the ceremony. At all events, as soon as the Society he suggested was successfully established and flourishing, he retired from its concerns, though for some four years he seems to have devoted himself energetically and without much pecuniary reward to its establishment. For the first year after the Society was formed he acted as secretary without pay. When the Society was formally constituted in 1755 he was appointed secretary, and this post was afterwards, in 1757, changed to that of registrar.

In October, 1760, at a regular meeting of the Society, a letter from Shipley was read "acquainting the Society of his having lately engaged in business of such importance as to render him incapable of discharging his duty to the Society as their register without very much injuring

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the "Concise Account," however, extracted a good deal from Theobald's narrative, and it is from this source that most of what we know about Shipley and his efforts to start a society are derived. A short life of Shipley is given in "Russell's History of Maidstone" (1881), and this gives some particulars of his later years. This information is reproduced in a short article in the *Journal* (Vol. XXX. p. 933), written by H. B. Wheatley. The account in the "Dictionary of National Biography" is based on this article, though other references are given. One or two mistakes appear in this account. Shipley was in all probability born in London, not in Maidstone, and he certainly died in Maidstone, and not in Manchester.

* "Dictionary of Artists of the English School."

† A note in the *Gentleman's Magazine*, March, 1758, p. 141, records the opening of this school. A room was supplied with busts and pictures for the use of art students. Wilton and Cipriani were engaged to attend at certain times and examine the students' work.

‡ "My late father, Nathaniel Smith, and Joseph Nollekens were playfellows, and both learned drawing together at Shipley's School, then kept in the Strand, at the eastern corner of Castle Court; the house, now No. 229, is at present occupied by Mr. Helps. What renders the building the more interesting is that it was not only in this house that the Society of Arts had its first meetings, but it was subsequently inhabited by Rawle, the antiquary, and friend of Captain Grose."—J. T. Smith, "Nollekens and His Times," 1828, Vol. I., p. 3.

* This is the date given in all the biographical dictionaries. The same year is given as the date of the birth of his brother Jonathan, and in his case correctly, as is shown by his monument in the churchyard at Twyford, near Winchester. The date on William's tombstone in All Saints' Churchyard, Maidstone, is illegible. Probably Jonathan was the elder brother. He inherited his mother's property at Twyford.

his own affairs." What this business was does not appear. It may have been the development of his academy. At all events, his resignation was accepted with thanks for his past services. That his retirement was not due to lack of appreciation of those services may be assumed from the fact that he was made a "perpetual member" of the Society in 1755, was presented with its gold medal in 1756, and had his portrait painted for the Society by Cosway, his former pupil. It may be that his capacity lay rather in the direction of origination than of administration. At all events, we hear no more of him in connection with the Society after 1760. In 1768 he went to live at Maidstone, where he was married, and remained until his death in 1803. He was buried in the churchyard of All Saints' Church. All that is known of his life at Maidstone is that he established a local Society on the same lines as the Society of Arts, and busied himself in philanthropic work.

Shipley, having published his scheme, set to work to secure the help of influential people, and succeeded in interesting, amongst others, Lord Folkestone and Lord Romney, to whom, with Shipley himself, must be given the credit of founding the Society of Arts. Indeed, it appears that if Shipley originated the idea, Lord Folkestone carried it into execution; and, in all probability, without his practical help and his influence there never would have been a Society of Arts.

On March 22nd, 1754, there was held at Rawthmell's Coffee House, Henrietta Street, Covent Garden,* "A meeting of some Noblemen, Clergy, Gentlemen and Merchants in order to form a Society for the Encouragement of Arts, Manufactures and Commerce in Great Britain." Eleven in all attended:—Viscount Folkestone;† Lord Romney;‡ Dr. Stephen Hales, F.R.S. (the eminent physiologist, botanist, and inventor, a friend of Pope); Henry Baker, F.R.S. (naturalist and author; he married Defoe's youngest daughter); Gustavus Brander, F.R.S. (merchant and antiquary, a director of the Bank of England); James Short, F.R.S. (optician and astronomer); John Goodchild (afterwards treasurer to the Society); Nicholas Crispe (watchmaker, of Bow Churchyard); Charles Lawrence; Husband Messiter (a surgeon, then resident in Great Pulteney Street); William Shipley.

A very modest beginning was made by considering a suggestion by Shipley that two prizes should be offered, one for the discovery of cobalt and the other for the growth of madder, in the kingdom. It was determined to make further inquiries and a decision was postponed. The meeting further resolved "to bestow premiums on a certain number of boys or girls under the age of sixteen who shall produce the best piece of drawing, and show themselves most capable when properly examined, "it being the opinion of all present that the Art of Drawing is absolutely necessary in many employments, trades, and manufactures." This early anticipation of views which in our own time were put forward as novel by the advocates of technical education is interesting. That they were really Shipley's ideas, and that his intention in proposing the formation of the Society was not merely to extend or improve his own "drawing academy" is shown by a letter written a couple of years later by him in the *Gentleman's Magazine*,* in which he combats vigorously the suggestion that the Society was merely occupied in training young people to become artists, and announces as one of the chief objects of the Society the training of both boys and girls in the industrial arts. Thus it can be truthfully said that from its first foundation the Society has taken an active part in the promotion of technical education.

A fortnight after the inaugural meeting a second meeting was held (March 29th), and at this further progress was made. A definite decision was arrived at to offer the cobalt and madder premiums, and a subscription list opened. Lords Folkestone and Romney headed the list with a donation of ten guineas apiece, and further promised to guarantee whatever further sums might be required, so that an announcement might be made of the offer of prizes. The Earl of Shaftesbury also sent ten guineas, and four others gave two guineas each. Funds being thus available, an advertisement was inserted in the *Daily Advertiser*, offering prizes of £30 each for specified amounts of cobalt and madder, and two prizes of £15 each for drawings by boys and girls below fourteen and between fourteen and seventeen. The competitive drawings were

* The precise locality of Rawthmell's Coffee House is described in an article in the *Journal*, Vol. LVIII., p. 384.

† Sir Jacob Des Bouveries (afterwards Bouverie) was created Viscount Folkestone in 1747. His father and grandfather were well-known Turkey merchants in London. His ancestor, Laurence des Bouveries, a native of Flanders, and a silk-weaver, settled in Canterbury in 1568, about the time when so many Flemish immigrants came to England to escape the persecutions of Alva. The title was merged in that of Radnor when the second Viscount Folkestone was created Earl of Radnor in 1765.

‡ Robert Lord Romney was the second Baron. He was a brother-in-law of Lord Folkestone, who had married his sister, the Hon. Elizabeth Marsham.

* January 28th, 1756, p. 61.

to be sent in on January 15th, 1755, and the prizes were to be awarded a fortnight later. Thus the practical work of the Society was begun.

Six more meetings were held during the year in a circulating library in Crane Court, Fleet Street, in which court was the house then occupied (from 1710 to 1780) by the Royal Society. These were all small meetings, of the nature really of committees, and at them the organisation of the Society was worked out, subjects for premiums discussed, and a general plan of action decided upon. Amongst other things it was decided to have a regular meeting on the second Wednesday in each month, and a committee on each fourth Wednesday.

By the end of the year all preliminaries seem to have been arranged, and it was decided to organise the Society on a more regular basis with a president and officers. This decision was arrived at at a meeting held in January, 1755, at Peele's Coffee House at the corner of Fetter Lane and Fleet Street.

At the same meeting the prizes offered for drawings were adjudged. The only name amongst those of the prize-winners which is still remembered is that of Richard Cosway, who took the first of the five prizes offered for drawings by young people under the age of fourteen. J. T. Smith, in his "Life of Nollekens," tells us that Cosway was then employed as a waiting lad at Shipley's Academy. He was afterwards a Royal Academician and an eminent portrait painter and miniaturist. John Smart, who took the second prize in the same class as Cosway, afterwards obtained considerable success as a painter of miniatures, and exhibited miniatures and oil portraits at the Royal Academy up to the time of his death in 1811. The third prize went to John Alexander Gresse, afterwards a painter of reputation, and the fourth to Barbara Marsden, who became a flower painter, and married Jeremiah Meyer, R.A. None of the candidates in the senior class appear to have achieved any artistic success in after life.

In the following month (February 5th) Viscount Folkestone was elected the first president, with Lord Romney, Charles Whitworth, James Theobald, and Stephen Hales, vice-presidents. John Goodchild was made treasurer, and William Shipley, secretary. At the same meeting Shipley and Henry Baker were elected "perpetual members." The Society was thus regularly constituted, and from that date forward meetings were regularly held for the election of new members and the transaction of business.

The title of the Society has always remained that which Shipley suggested in his original scheme, "The Society for the Encouragement of Arts, Manufactures, and Commerce," but this soon proved too long and cumbrous, and very soon after its foundation the shorter name, "Society of Arts," was adopted. In the *Gentleman's Magazine* of July, 1755, it is so called, and this soon became the name by which it was popularly known. Sometimes it is referred to as the "Society of Arts and Sciences," and in its own early books of accounts it is called "The Premium Society," though this title does not seem to appear elsewhere. The earliest known official use of the shorter name appears in the minutes in February, 1811, and from that time onwards it is constantly found. The full title was unfortunately adopted in the Charter in 1847, and the two names were used until King Edward VII., in 1908, granted the Society permission to add the word "Royal" to its title.

The constitution of the Society, at first and for very many years, was on a purely democratic basis. It had no governing body. There were certain standing committees and others appointed from time to time for special purposes, but their duty was merely to prepare the business for the general body of members, by whom all the business was transacted. The "ordinary meetings" were held first on alternate Wednesdays, and afterwards on every Wednesday from November to May, with less frequent meetings from May to November. The ordinary meetings were not competent to alter the "rules and orders." This could only be done at "general meetings," the number of which seems to have varied from time to time. At the ordinary meetings all the regular business of the Society was transacted, members were proposed, balloted for, and elected, bills were ordered for payment, and expenditure was discussed. Above all, subjects for the award of prizes were considered and voted upon.

It must be borne in mind that the sole object of the Society was to award premiums for meritorious discoveries and inventions, and for advances of any kind in arts, manufactures, and commerce. The meetings had before them descriptions of such advances, reports upon them, suggestions for new premiums, applications from inventors, but all these were merely intended to assist in the selection of suitable subjects for awards. The Society of Arts did not, like the Royal Society, welcome the description of new branches of knowledge (even of practical or applied knowledge); they

did not invite their members to contribute essays or read memoirs or give lectures—all that came later. They simply hoped to encourage industry and art by rewarding those who helped in the promotion of art and industry, and to give them either substantial money gifts, or honorary rewards in the nature of medals. Later, when the Society came to publish transactions, it received suitable information readily enough, gave the author a medal, and printed his communication. Eventually the publication became more important than the award, but this was not so at first, or for very many years after the Society's foundation.

It will be seen that the one idea of the founders of the Society was to encourage arts and industries by the offer of prizes. It appeared possible to them that a committee of gentlemen, sitting in London, would be able to ascertain what the pressing needs of the public were, to foresee the course which industrial development could most wisely take, to select those inventions which could most usefully be encouraged, and generally to direct, by the judicious apportionment of medals and money prizes, the development of industry and the progress of art. To us, nowadays, the whole scheme seems trivial and ridiculous, but at the time it was perfectly reasonable, and it commended itself to the shrewdest economists. As a matter of fact, it obtained a very considerable measure of success, and that it was extremely popular is shown by the support it received from the most influential people of the time.

An attempt has been made elsewhere* to indicate the industrial conditions of the era. Here it may suffice to remind the reader that the time was essentially one of industrial change. The old conditions of regulance and support had long since disappeared. The new conditions of competition and the absence of restriction were not yet conceived, let alone formulated. The various young industries, textile, metallurgical, chemical, ceramic and the rest, all wanted patronage and help. They wanted, too, advertisement and notoriety. All this they got from the newly-formed Society, and it may fairly be said that, having due regard to the then existing conditions, and to the state of public knowledge, it would be very difficult indeed to suggest any scheme better adapted for its purpose than that of Shipley and his patrons.

The annual subscription was fixed at "not less than" two guineas, and for a long time it was the practice of the more wealthy or more liberal members to pay three guineas. This excellent custom, however, has for many years been abandoned, though the wording of the old rule has been preserved. Peers were expected to pay five guineas, and for the most part did so. In a single instance, this practice survived into our own time. The late Marquis of Ripon (who was elected in 1856 and died in 1909) always subscribed five guineas annually. The composition for life membership was settled at twenty guineas, and has never been altered, though occasionally larger contributions were made. The great Earl of Bute, not by reputation a liberal or extravagant donor, gave forty pounds for his "perpetual membership."

The Society has never received any official aid. Less fortunate than the sister institution in Dublin, or than many of the great London societies which have taken over much of its original work, it has never been supported or helped in any way by Government. Lecky, in his "History of the Eighteenth Century," * says that it received a grant of £500 from the Corporation of London, but a careful search through the early account books has produced no confirmation of this statement.† In 1765 the Society received a donation of £100 from the Corporation of Liverpool, and this appears to have been the only contribution of the sort.

The Society was soon in a very satisfactory financial position. In 1755, the first year after its formal constitution, its income was £360. In the following year it was £632, and in 1757 it was £1,203. In the next six years it mounted steadily, £1,731 in 1758, £2,001 in 1759, £3,482 in 1760, £3,656 in 1761, £4,533 in 1762, £4,614 in 1763. Then, in 1764 there was a drop to £4,131.

At first all the Society's cash was in the hands of the treasurer, who was subject only to the control of a finance committee, which audited and reported on his accounts at intervals. The first treasurer was John Goodchild, one of the founders. He was elected in 1755, and held office until his death at the end of 1756, when he was succeeded by his son, also John. A year later we find a committee reporting on the treasurer's accounts "that the receipts and disbursements are right, but kept in rather a perplexed method." Probably the younger

* "Industrial England in the Middle of the Eighteenth Century." Murray, 1910.

* Vol. VII., p. 207 (Edition 1907).

† The books commence with 1755, the first entry being dated April of that year. If such a grant had been made in 1754 it could hardly have escaped notice in the minutes which record all the meetings, from the first at Rawthmell's onward.

Goodchild was a bad accountant, for in 1759 he was in difficulties and had to compound with his creditors, the Society in consequence suffering some small loss. The office of treasurer was thereupon declared vacant, and subsequently abolished. Careful regulations were then laid down as to finance, and it was ordered that all the Society's funds were to be kept in an account at the Bank of England in the names of the President and Vice-Presidents.

In an appendix to the premium list issued by the Society in 1764, there is a tabular statement of the "Receipts and Disbursements" for the nine years 1755 to 1763. The total receipts were £22,295, and the total expenditure was £18,756. Of this £8,496 was spent in money prizes and medals, £3,507 on a special grant for a system of land carriage for fish, £291 on the Society's exhibitions, and the balance of £6,462 on general administration, including rent, salaries, advertising, printing, etc. It is clear from this that the affairs of the Society were carefully and economically managed, for the cost of management as compared with the amount of the funds expended is very reasonable.

A later statement, issued in 1778 in the form of a "Register of the Premiums and Bounties given by the Society" up to the end of 1776, showed that the total amount given away by the Society was then £24,616, of which £23,552 had been money prizes, and £1,064 had been the value of the medals awarded. It may be noted that "premiums" were awards to "candidates who claim under the terms of the annual advertisements of the Society," and that "bounties" were "bestowed on merits that have not been previously called for by the Society, or that do not precisely come within the terms of the annual advertisements." It is added that "these amounts have been distributed all over Great Britain, Europe, and America"—a good general statement, which perhaps was not intended to be taken as minutely accurate.

As previously mentioned, during the first year of the Society's existence Shipley acted as secretary, at first unpaid. When the Society was formally organised in February, 1755, Shipley was appointed secretary. He appears to have had some clerical assistance provided for him, and in January, 1756, George Box was appointed assistant secretary. In March, 1757, Shipley was elected registrar, and Box was made secretary. The registrar was apparently the more important officer of the two, but the secretary did most of the work. It looks as if it had been desired to make his duties a little easier for Shipley, and to find somebody who was more methodical and businesslike to carry on all the routine business. Not very much is recorded of George Box, though it is evident that he was a most efficient and competent official. He served the Society faithfully for twenty-five years, and such records of him as appear from time to time in the minutes show that he was entirely trustworthy and possessed the regard and confidence of the members.

In 1760, soon after the Society, as will be hereafter related, had established itself in the house opposite Beaufort Buildings in the Strand, where it remained until it moved to the Adelphi, it was decided that a more competent and better-qualified secretary was required. A committee reported in February, 1760, that the proper conduct of the Society's work required a man of "general and technical knowledge," able to deal with scientific questions and conversant with foreign languages. "He ought to be a man of character and a man of learning," and such a man the committee thought might well deserve a salary of £200 a year. The general body of members approved the qualifications, but set a lower estimate on their value, and considered that the required person might be obtained for £150. The committee went on to recommend the appointment of an assistant secretary with a salary of £50 and a commission of 6*d*. in the pound on subscriptions, which at the time must have meant another £75 a year, so that the pay of the two officials was not very different. It is evident that the committee wished to do the best they could for Box, though they felt that he was not quite qualified for the more important post, since they add that they "take the liberty from the long experience of the diligence and integrity of your present secretary to recommend him to the office of assistant secretary and receiver." Later resolutions decided that the names of both officials were to appear in the Society's lists and other publications.

It was finally decided to appoint Box assistant, and to advertise for a secretary. As regards the office of registrar, the committee considered "the present register a very proper person to be continued in that office, and that he should do the business as usual"; that he should "have the salary and appartments now allowed him," and that he should be "allowed £10 a year more for taking care of the rooms, cleaning them and the furniture, and keeping all things in proper order for the reception of the Society."

This looks as if the Society desired to provide a home and an easy post for Shipley without expecting from him very much useful work.

In response to the advertisement four candidates applied—Dr. Templeman, Dr. Maty, Dr. Mitchell and Mr. Robert Dossie. It has often been said that Oliver Goldsmith was a candidate, but, as a matter of fact, though he thought of sending in his name, and applied to Garrick for a testimonial, he never actually went so far as to make formal application. The authority for the statement is Thomas Davies, who, in his "Life of Garrick,"* tells us that Goldsmith asked Garrick to recommend him, but that Garrick had been annoyed by Goldsmith's criticisms, and rather curtly refused. Forster, in his "Life of Goldsmith," adopted Davies's story:—

"Thomas Davies tells us that when, somewhere about the time of his connection with the *Bee*, Goldsmith sought to obtain, what a struggling man of letters was thought to have some claim to, the vacant secretaryship of the Society of Arts, Garrick made answer to a personal application for his vote, that Mr. Goldsmith, having 'taken pains to deprive himself of his assistance by an unprovoked attack upon his management of the theatre in his "Present State of Learning,"' it was 'impossible he could lay claim to any recommendation from him.'" †

The compiler of this chronicle would like to think that Oliver Goldsmith had been an occupant of the post he now holds, though he realises that the talents of that charming writer were better employed in producing the "Vicar of Wakefield," "She Stoops to Conquer," and "The Deserted Village," than in discharging the routine duties of an office which no doubt was better filled by the successful competitor, Dr. Templeman. Still, the name of Goldsmith on the list of the Society's officials would have added not a little distinction to that list, even if, as would probably have been the case, he had not held an uncongenial office for very long.

Of the four candidates who actually did enter, Templeman was elected by a considerable majority. Box was appointed assistant secretary, in accordance with the recommendation of the committee. Later in the year Shipley, as previously mentioned, resigned his office of registrar, perhaps not liking the new conditions, or perhaps, as he said, on account of his other occupations.

Templeman was a man thoroughly well qualified for the post of secretary to a young and growing society. He had a distinguished career at Cambridge, where he graduated from Trinity in 1731. He studied medicine in Germany, and in 1737 he obtained the degree of M.D. at the University of Leyden. After this he started practice in London, but being fairly well off he devoted himself to literature rather than to the practice of his profession. In 1758 he was appointed Keeper of the Reading Room at the newly-established British Museum, and he gave up this post for the secretaryship of the Society. He was the author of numerous medical books, and in 1762 he was elected a Corresponding Member of the Royal Academy of Science of Paris. He was a fine scholar, a good linguist, and an accomplished man, well fitted for the post to which he was elected, and which he held until his death in 1769.

The duties of the three principal officers were laid down with great precision in the Society's "Rules and Orders." The secretary was generally responsible for the proper conduct of the Society's business and the due keeping of its records. The assistant secretary had to do all the clerical work, and the registrar had charge of the Society's property, and was required to look after the premises. In addition, there was a collector, who had to collect subscriptions and to pay them into the bank. He was paid by commission and had to give security.

(*To be continued.*)

SUDAN EXPORTS.

When the Central Economic Board of the Sudan Government came into being a few years ago, the value of the exports from the Sudan was estimated at about £E264,000, a very small sum when it is remembered that the territory extends for 950,000 square miles. To deal with such a limited amount may seem, at first sight, an easy matter. At the same time there has been no little difficulty in selecting a general policy, especially as the trade is passing through a transitional period. Experience shows that it is better, for the time being, to depend on the familiar conditions known to the native than to endeavour to induce him to adopt means of livelihood with which he is not acquainted.

The making of the railway to Port Sudan, and the improvement of trade routes, have shown that, under the prevailing circumstances, rain-grown products are of more importance, economically, than cultivation by mechanical means north of Khartoum.

Private capital is required to develop cotton cultivation in Northern Sudan. As this is not forthcoming, it is found best to devote all funds available to extending railways and instituting

* Vol. II., p. 149.

† Forster's "Life of Goldsmith," Vol. I., p. 239.

nucleus trading depots. The transport question is being rapidly disposed of, but agricultural problems in the Southern Sudan have not yet been tackled. The development of the cattle trade depends on the scientific skill which can be applied to the prevention of animal diseases. There are, at present, not sufficient funds to take this matter fully in hand.

It is only a very few years since the exports of the Sudan might be roughly summed up as gum, ivory, and ostrich feathers. The list of Sudan exports now includes live-stock, hides and skins, rubber, beeswax, mother-of-pearl shell, wheat, millet, barley, cotton and cotton-seed, sesame, ground nuts, dates, senna, and gold. The value of exports, which in 1906 stood at £E264,096, is now £E673,902. Some 80 per cent. of the exports of 1909 were rain and flood products. In view of the development of the food products of the Sudan, it is hoped, before very long, that the country may furnish a very large proportion of the food supply of Egypt, and may also help to solve the labour difficulty by drawing agriculturists to the Sudan.

The extension of the Sudan trade to external markets will necessitate transport and co-operation between the Government and the public. The Sudan Chamber of Commerce has already reduced rates on dura (millet) from Port Sudan to Suez and elsewhere. The Government have been glad to make use of its services in putting foreign correspondents in touch with local merchants.

For a considerable time agricultural loans have been in force in the Sudan. These are now to be extended to the purchasing of selected cotton seed for the Tokar district of Red Sea Province. If this should result in the quality of the cotton grown in that district being raised to the Egyptian standard, it would be a good argument for the institution, by joint Government and public contribution, of ginning and pressing machinery sufficient to deal with the crop, and so make possible the direct export of cotton from Port Sudan to Europe.

For some time the technical department of the Gordon College has been ginning cotton for the public at Khartoum and in Kassala.

At Port Sudan the completion of the quays has permitted the substitution of mechanical for manual handling, and bonded warehouses are to be instituted at Khartoum and Port Sudan.

The construction of the Blue Nile Railway will bring crops on to the market at the same time as those from the White Nile and Kordofan districts. Although the White Nile is open to traffic all the year round, the Blue Nile is not navigable for quite six months in the year. With the exception of products borne on the backs of camels, Blue Nile products have hitherto reached Khartoum market some months later than those from the White Nile. If the crops could arrive simultaneously, it would steady the price of certain commodities, such as sesame and dura. Now, if dura would maintain a fairly low price in the Sudan, it is quite possible that there would be a steady annual export to Egypt. There is also no reason why the Sudan should not provide all the sesame needed in Egypt. The railway will be of great service to the cattle-producing areas in the Sudan, and will bring the Abyssinian frontier into closer touch, although, up till now, the efforts to extend trade in Abyssinia have not been very successful.

Part of the programme of the Economic Board has been to substitute production in the Sudan for imports from abroad. A table published in 1907 showed that imports of certain commodities amounted to £E237,000. These articles are wheat, maize, barley, rice, flour, dates, sugar, timber, and salt. It will take some time to carry the policy into effect, but the basis is being laid. The chief export is gum. The crop of 1909 is the largest recorded, and reached 13,282 tons. The new railway between El Obeid and the White Nile will produce a complete change in the conditions of transport. It is likely that the extension of the line along the White Nile will help to develop the gum trade in the districts along the river. The Governor at Khartoum is attempting to put an end to some of the abuses in connection with the porterage and weighing of gum at Khartoum. The export of dura developed more than any other commodity last year. Dura is easily grown. It remains to be seen whether the big crops will continue steadily, or whether the natives will be industrious by fits and starts. The large export of dura during the last two years has been due to the reduction of the railway rates at a time of scarcity. Egyptian merchants were quick to take advantage. Sudan dura was exported in such quantities that private transport could not cope with it, and Government had to lend assistance. The question of how to maintain the big crop is being dealt with. The desirability of developing traffic between Port Sudan and Suakin has been put before the Khedivial Mail Steamship Company.

Oil seeds form a considerable item of the Sudan exports. The most important of these is sesame. It has already been put on European markets with profit, and sesame and sesame oil are in large demand amongst the native population.

Ground nuts have been cultivated on some estates, under European management, to the north of Khartoum. The rain districts to the south of Khartoum should also offer a good field in course of time.

Experiments made in the growing of castor seed show that it can be cultivated in certain districts with good results.

The unreliability of the water-supply in the Tokar district has caused a less area to be put under cotton cultivation during the last two years, and so there has been a decrease in the total exports of ginned cotton. In spite of the uncertainty of the water-supply, the Tokar cotton is of great value to the country. The Government are at present occupied with the question of providing good seed, the native cultivator not being sufficiently particular in this respect.

The Sudan possesses very large supplies of cattle, sheep, and goats, and these should form a large

and permanent export to Egypt, now that the principal veterinary officer has prepared a scheme by which the live-stock can be moved to Egypt under veterinary supervision.

Nearly the whole of the date crop gōes to Egypt. Unfortunately, the owners cannot or will not wait until their dates are ripe before selling, so they lose part of the profits.

The following table gives the value of the chief Sudan exports for the year 1909, in Egyptian pounds:—

Gum	£E371,896
Dura	136,599
Sesame	63,066
Ground Nuts	3,594
Ginned Cotton	39,283
Sheep and Goats	39,395
Ivory	45,056
Dates	35,306

ARTS AND CRAFTS.

Home Arts and Industries.—The difference between the way in which home arts and industries used to be regarded some twenty years ago, and the point of view from which we look upon them now, is very clearly shown by the change which has, little by little, come over the annual exhibition of the Home Arts and Industries Association. This used at one time to consist almost entirely of the work done in winter evenings in village and town classes, or by married women and girls in the country in their spare time. To-day, though a very fair proportion of the work comes from sources such as these, they can hardly be said to provide the bulk of the exhibits, still less to supply them exclusively. A number of the stalls at the Albert Hall this year were given over to "Affiliated Societies," described in the programme as "classes and industries that are held in connection with any Society, Institution, Guild, or Home"—which include several agencies for the employment of the blind, crippled, and feeble-minded—whilst many others were devoted to "developed," or "partially-developed industries," explained, in their turn, as industries that are wholly or partly self-supporting, with full-time or part-time workers, and either a paid management and depôt or receiving voluntary help in management or loans of capital. Thus the work shown under the auspices of the Association at the present time varies from the modest output of the village class to what is really handwork produced more or less in the way of trade—sometimes so completely trade as to make one wonder how the industry comes to be represented at a semi-philanthropic exhibition like the Home Arts, sometimes charitable to such an extent that one feels it is really only the courtesy and good feeling of the classholder which cause it to be labelled as anything but an ordinary class. From one point, of view, of course, the exhibition suffers rather from this mixture in the types of workmanship represented. In most industries the work of the man who does his handwork more or less as a recreation will not, of course, bear comparison with that of one who is earning his living at it. Moreover, the show is not so much of a homogeneous whole as it used to be. On the other hand, the mere fact that classes and associations of such utterly different types are represented is perhaps one of the strongest imaginable proofs both of the strength of the movement at the present time and of the work that it has done in the past. When the Association was first started, work executed by classes whose workers were supporting themselves by their handiwork was not exhibited, for the excellent reason that it practically did not exist—and the fact that such work is so plentiful as it is at the present day is due, at any rate, in some measure to the efforts of the Home Arts and Industries Association. The crafts most fully represented this year were embroidery, lacemaking, and woodcarving. The cutwork from Langdale was, as usual, exceedingly good, and there were interesting exhibits from Windermere, Wilton and the Dune Emer Guild. The coarse couched crewel work from the last-named class (executed, by the way, in the hand) was really peculiarly effective. Some of the lace was very well made, though the designs were not always all that could be desired. There seems to be a tendency to make more Honiton lace than formerly outside the limits of the county of Devon. Many of the weaving exhibits were characterised by the pleasant colour of the materials; and the simple but effective pattern-weaving shown by the Barclay workshops for the blind was very tasteful. Inlay work, after a period of depression, is well to the front again this year, and some of the leather-work classes sent important exhibits. There was an attractive show of work executed in Niger leather from Leighton Buzzard, and this exhibit included some lacquered leather much less hard and glaring in colour than the work of this kind which has been shown before.

Simple Homes and Furniture.—The House and Home Exhibition at the Whitechapel Art Gallery has much to connect it with the Home Arts and Industries. One of the aims of the show is to demonstrate the futility of fussiness in furniture and decoration, and the advantages of simplicity, with the result that the furniture and fittings exhibited are, for the most part, hand-made. Mr. Ernest Gimson, the Artificers' Guild, and others, sent plenty of good workmanship in wood and metal, whilst the coarse appliqué embroidery lent by the Peasant Arts Society is much of it very effective. The exhibition as a whole does a very needful bit of work in insisting upon the beauty of simple furniture and the superfluity, as well as the ugliness, of much that is taken to be essential in a modern home of even the most modest proportions. But there is a certain amount of affectation of simplicity in some of the exhibits which, apart from being undesirable in itself, will probably hinder the usefulness of the object-lesson to

the very people to whom it is particularly meant to appeal—quite apart from the consideration that the price of these things, simple as they are, would in many cases be quite prohibitive to all but the more than ordinarily well-to-do. Again, the people who are especially and pre-eminently lovers of fresh air and country cottages, seem to find it very difficult to realise that furniture which is admirably adapted for rural districts may be, and often is, quite unsuitable and out of place in a town dwelling. The two little bays described as "Two Stepney Rooms" are really, in spite of one or two unnecessarily ugly touches, the part of the collection which may be expected to appeal most strongly to the people who live in the neighbourhood of the Whitechapel Art Gallery—for they are eminently practical, and even though one might like, personally, to alter one or two things in them, they do represent a way of furnishing a working-man's home which is pleasanter than the arrangements one habitually sees, without being appreciably more expensive. The usefulness of this section would be considerably increased if a list of the prices of the various objects were hung up near by. The pottery shown needs just one word of comment. Some good pieces of a comparatively expensive kind of ware are shown by Messrs. Pilkington and Messrs. Martin, but the ordinary crockery arranged on the dressers, etc., is uglier and commoner looking than that which one usually sees in a working-class home. It is, of course, easy to find fault with details, but the promoters of the exhibition now open at Whitechapel are to be congratulated, both on the happy thought which inspired their exhibition for this year, and on the skill and thoroughness with which they have carried it out.

The Guild of Embroideresses.—Exhibitions of embroidery are apt to be rather in the nature of glorified bazaars, or to be held under the patronage of so many noble patrons that one begins to wonder whether the embroideresses themselves have any interest in them beyond the purely commercial one of selling their work. The little show held at the Modern Gallery towards the end of May, by the Guild of Embroideresses, marked a real effort in a healthier and a better direction. The patrons of the guild, amongst whom may be mentioned Sir Alfred East and Mr. Walter Crane, are all artists of repute, and its members consist of needlewomen, both professional and amateur, who are really interested in embroidery, practical, theoretical, and historic, for its own sake. The exhibition, which was opened by the Slade Professor of Fine Art at Oxford, Mr. Selwyn Image, though small, embraced a variety of kinds of work, and was by no means devoted to showing stitchery or design of any one particular type. Perhaps the most striking exhibits were a curtain and a cushion worked by Mrs. Newberry from old Macedonian designs, which, both in their colouring and stitchery, were all that could be desired. Miss Louisa F. Pesel's rendering in embroidery of designs from plaster work at San Sophia and from an Oriental MS. were also most satisfactory pieces of workmanship and of colour. In a very different way, the large appliqué figure panels by Miss Ethel Higgins, boldly executed in rose-red velvet on a neutral-coloured ground, were a model of what work of that particular type should be. The most wonderful piece of fine needlework was a little Japanese scene worked by Miss Sealy in white thread on fine white muslin. Its execution must have involved an almost incredible amount of labour, but as a *tour-de-force* it was very well worth doing. Miss Janet Swindells showed some beautiful satin stitch, Miss Tann several very tasteful colour-schemes, and Miss Pryce an excellent gold sampler. Taken as a whole, the exhibition sent one away with the feeling that, however much the work in London and one or two of the large provincial towns may be inclined to move in one rather narrow groove, there are still plenty of competent workers who look at their craft from a wider point of view. While this is the case, there is always a reasonable hope that things will, in the long run, right themselves.

CORRESPONDENCE.

IMPROVEMENTS IN THE TRANSPORT AND DISTRIBUTION OF GOODS IN LONDON.

I have received the enclosed letter from a friend who has great experience and wide knowledge with regard to the transportation of parcels and goods in London, and I think it will be of interest to those who have followed the correspondence which has arisen on the subject of my recent paper to members of your Society.

A. W. GATTIE.

[*Enclosure.*]

I have been much interested in the matter contained in recent issues of the *Journal* about the proposed Clearing House for Goods, and have noticed especially a letter signed "S. Chapman," in which the writer says:—

"It may be taken for granted that the bulk of orders coming by post arrive by the early morning deliveries. These orders are dealt with in the course of the day, and are ready towards evening for collection in order to be sent to various parts."

I am in entire disagreement with this statement. I maintain that the one reason why the packages for luggage rail are not ready till towards evening is because there is no system of collection by the railway companies earlier in the day, and in consequence the goods have to be held over, often at serious inconvenience to the traders who have none too much room in their warehouses.

It may interest your traders to know that nine-tenths of the big City and West-End houses collect

the morning's mail by special messengers from the district post-office. Such people as Cook, Morley, Rylands, Howell, Sharp Perrin, Foster Porter, etc., in the City, and Whiteley, Harrod, Selfridge, Schoolbred, Maple, etc., in the West-End, have their letters in the house by 6.30 a.m., and in many cases special orders are dealt with and out for delivery in their own vans by 8 o'clock, and frequently the orders are put in hand at once and dispatched as early as possible throughout the entire day.

Sutton & Co. close their gates at 4 p.m. sharp (Saturdays 1 p.m.), yet the railway companies are receiving hours after this, and, although they profess to close at 6.30, many vans enter the goods yards after 8 o'clock.

There are hundreds of City firms who would welcome an early dispatch, but who now put off the packing of package for goods trains till after 4 p.m., otherwise the packages are in their way.

I am convinced that the Clearing House will remedy this present unsatisfactory state of things, and am prepared to give it a hearty welcome.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 12...Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Chemical Industry (London Section), Burlington House, W., 8 p.m. Mr. H. de Mosenthal, "Observations on Cotton and Nitrated Cotton."

Geographical, Burlington-gardens, W., 8.30 p.m. Dr. Arthur Neve, "Some Explorations in the Himalayas."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. E. Richmond, "Egyptian Architecture."

Actuaries, Staples Inn Hall, Holborn, W.C., 5 p.m. Annual Meeting.

Victoria Institute, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Rev. W. St. Clair Tisdall, "Mithraism: Christianity's Greatest Rival under the Roman Emperors."

TUESDAY, JUNE 13...Asiatic, 22, Albemarle-street, W., 4 p.m. Mr. A. B. Keith, "The Vedic Ākhyāna and the Indian Drama."

Alpine Club, 23, Savile-row, W., 8.30 p.m.

Statistical, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.30 p.m. Sir J. Athelstane Baines, "Under the Crown."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. E. Sanger Shepherd, "On the Cause of Reversal and its Remedy, with Some Notes on the Photographic Process."

Zoological, Regent's-park, N.W., 8.30 p.m. 1. Dr. R. E. Drake-Brockman, "On Antelopes of the Genera *Madoqua* and *Rhynchotragus* from Somaliland." 2. Hon. Paul A. Methuen, "On an Amphipod from the Transvaal." 3. Mr. R. Lydekker, "The Somali Rhinoceros and the Nigerian Klipspringer." 4. Mr. C. E. Hellmayr, "A Contribution to the Ornithology of Western Columbia." 5. Professor Angel Cabrera, "The Subspecies of the Spanish Ibex."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. Address by Sir Joseph Ward, Prime Minister of New Zealand.

Faraday Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Professor Ernst Cohen (of Utrecht), "Allotropic Forms of Metals."

Gas Engineers, Glasgow and West of Scotland Technical College, Montrose-street, Glasgow, 10 a.m. Annual General Meeting. 1. Address by the President. 2. Report of the Carbonisation Committee. 3. Third Report of Gas Heating Research Committee. 4. Report of the Refractory Materials Research Committee. Selections from following papers:—5. Mr. C. F. Broadhead, "Modernising a Medium-sized Undertaking." 6. Mr. Bernard F. Browne, "Aspects of Gas Supply in a South American City." 7. Mr. Charles Drury, "The Dessau Vertical Retorts at Sunderland." 8. Mr. P. C. Holmes Hunt, "The Choice of a Carbonising System." 9. Mr. S. B. Langlands, "Public Lighting." 10. Mr. J. P. Leather, "The Woodall-Duckham System of Vertical Retorts." 11. Mr. James McLeod, "Notes on the Corrosion of Service Pipes." 12. Mr. J. G. Newbigging, "The Scientific Carbonisation of Coal." 13. Mr. E. W. Smith, "The Uses of High-pressure Gas for Industrial Heating Purposes." 8 p.m. Professor W. A. Bone, "Surface Combustion."

WEDNESDAY, JUNE 14...Meteorological, 70, Victoria-street, S.W., 4.30 p.m. 1. Dr. Charles Chree, "The Diurnal Inequality of Barometric Pressure at Castle O'er, Dumfriesshire." 2. Mr. Spencer C. Russell, "Rain Drop Experiments." 3. Mr. A. J. Makower, Dr. W. Makower, and Messrs. W. M. Gregory and H. Robinson, "Investigation of the Electrical State of the Upper Atmosphere, August, 1910."

Geological, Burlington House, W., 8 p.m. 1. Professor W. S. Boulton, "On a Monchiquite Intrusion in the Old Red Sandstone of Monmouthshire." 2. Mr. F. G. Collins, "Notes on the Culm of South Devon: Part I., Exeter District"; with a Report on the Plant-Remains, by Mr. E. A. Newell Arber, and Notes on the Cephalopoda, by Mr. G. C. Crick.

Chemical, Burlington House, W., 8 p.m. (Faraday Lecture.) Professor T. W. Richards, "The Fundamental Properties of the Elements."

Royal Archæological, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. G. C Druce, "Notes on the Heraldic Jall or Yale."

East India Association, Caxton Hall, Westminster, S.W., 4 p.m. Sir James Wilson, "Indian Currency Policy."

Gas Engineers, Glasgow and West of Scotland Technical College, Montrose-street, Glasgow, 10 a.m. Annual General Meeting continued.

THURSDAY, JUNE 15...Geographical, Savile-row, W., 5 p.m. (Research Meeting.) Dr. A. Strahan, "Report on River Investigation."

Antiquaries, Burlington House, W., 8.30 p.m.

Linnean, Burlington House, W., 8 p.m. 1. Miss H. M. Cunnington, "The Anatomy of *Enhalus acoroides*, Rich." 2. Professor A. D. Imms, "On the Life-history of *Croce filipennis*, Westw." 3. Professor J. J. Kieffer, (*a*) "Cynipidæ," (*b*) "Proctotrupoidea." 4. Professor T. D. A. Cockerell, "Apoidea." 5. Mr. J. C. F. Fryer, "Lepidoptera." 6. Mr. G. Meade-Waldo, "Wasps." 7. Mr. J. E. Collin, (*a*) "Borboridæ," (*b*) "Phoridæ." 8. Mr. F. V. Theobald, "Culicidæ." (Papers 3-8, relating to the fauna of the Seychelles, are communicated by Professor J. Stanley Gardiner.)

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. A. G. Vernon Harcourt and H. B. Baker, "The Alleged Complexity of Tellurium." 2. Messrs. W. R. Bousfield and T. M. Lowry, "The Purification and Properties of Acetic Acid." 3. Mr. S. U. Pickering, "Cupriglycollates."

Gas Engineers, Glasgow and West of Scotland Technical College, Montrose-street, Glasgow, 10 a.m. Annual General Meeting continued.

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FRIDAY, JUNE 16, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Fifty-Seventh Annual General Meeting, for the purpose of receiving the Council's report and the Treasurers' Statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the By-laws, on Wednesday, June 28th, at 4 p.m.

(By order of the Council),

HENRY TRUEMAN WOOD, *Secretary.*

SOCIETY'S ALBERT MEDAL.

The Albert Medal of the Society for the current year has been awarded by the Council, with the approval of His Royal Highness the President, to the Hon. Charles A. Parsons, C.B., LL.D., D.Sc., F.R.S., for his experimental researches into the laws governing the efficient action of steam in engines of the turbine type; and for his invention of the re-action type of steam turbine and its practical applications to the generation of electricity, the ventilation of mines, blast-furnace work, ship propulsion, and other important purposes.

The beneficial results which have followed upon these inventions include a cheapening of the production of mechanical power, greater economy and speed for steamships, and the first successful solution of the problem of rotary engines which long had baffled many other inventors.

PRIZE FOR LIFE-SAVING APPARATUS FOR USE IN NOXIOUS ATMOSPHERES.

At their meeting on Monday, the 12th inst., the Council had before them the following report of the Committee appointed to consider the applications for the above prize. They decided to approve the recommendations of the Committee, and to award medals in accordance with those recommendations, viz.:—

A gold medal to Mr. H. A. Fleuss, for the apparatus submitted by Messrs. Siebe, Gorman & Co.

A gold medal to Mr. W. E. Garforth, in recognition of his efforts to perfect and to secure the adoption of rescue apparatus in mines.

A silver medal for the "Draeger" apparatus submitted by Mr. Richard Jacobson.

A silver medal for the "Meco" apparatus submitted by the Mining Engineering Company.

REPORT OF COMMITTEE.

In the year 1907 the Council decided to offer, under the Fothergill Trust, a gold medal, or a prize of £20, for the best portable apparatus or appliance for enabling men to undertake rescue work in mines or other places where the air is noxious, the object being to encourage the production of a rescue apparatus which would enable a succouring party to reach men cut off —in case of mining accidents—by irrespirable gases, or overcome by them. It was known that many such appliances existed, but it appeared uncertain which of them were the best, or even which were of practical use.

In response to the offer a number of appliances were submitted by the specified date (March, 1908), and the Council appointed a committee to deal with them. It was intended that all the apparatus sent in should be submitted to practical trials, and it was hoped that this might be done and the award made without any very great delay. It turned out, however, that facilities for the purpose were unfortunately not immediately available, and, consequently, the proposed trials had to be postponed.

At the end of 1909 the Council were informed that facilities for carrying out tests would shortly be at their disposal, but so long

a time had elapsed since the original offer that some inventors who had notified their intention of competing had already made considerable alterations and improvements in their apparatus, and applications had also been received from other inventors, whom the Council would have been reluctant to exclude from the competition. After careful consideration of the circumstances, and having regard to the fact that the right was reserved of extending the time, the Council decided to cancel the original offer and to accept for competition any apparatus which might be submitted not later than March 31st, 1910.

The committee have carefully considered the various types of apparatus submitted to them, and they have had the advantage of also considering the results of the trials that have been made at various experimental stations, including the valuable and exhaustive series of trials recently made at Birmingham.

Since the proposal for a prize was put forward, many modifications have been made in the apparatus, and these also have been considered.

By the appointed date the following apparatus were submitted :—

1. The "Draeger" compressed-oxygen apparatus, by Richard Jacobson, 70, Shoe-lane, E.C., British Agent of The Draegerwerk (Heinr. and Bernh. Draeger), Lübeck.
2. The "Aerolith" liquid-air apparatus, by Henry Simonis & Co., Pretoria Works, Walthamstow, E.
3. The "Meco" compressed-oxygen apparatus by the Mining Engineering Co., Ltd., Foster's Buildings, High-street, Sheffield.
4. The "Weg" compressed-oxygen apparatus, with automatic supply, by W. E. Garforth, M.Inst.C.E., Snydale Hall, Pontefract.
5. Siebe, Gorman & Co.'s Fleuss compressed-oxygen apparatus (embodying improvements by Mr. H. A. Fleuss, Dr. Leonard Hill, F.R.S., and Mr. R. H. Davis), by Siebe, Gorman & Co., Ltd., 187, Westminster-bridge-road, S.E.
6. Apparatus for submarine work, using oxygen generated from a material termed "oxylith," by Captain S. S. Hall, R.N., H.M.S. "Mercury."

In addition to these there were two apparatus which were sent in late, and certain less important devices, which were eliminated by the committee after a preliminary examination.

It will be noted that of the above apparatus four depend on the supply of compressed oxygen, one on the provision of air evaporated from liquid air, and one—that of Captain Hall and Staff-Surgeon Rees, sent in by the first-named—on the production of oxygen from "oxylith." With regard to the last-named apparatus, there seems no doubt that though it is extremely well adapted for the purpose for which it was constructed—for use in submarines—it is not at present adequate for use in mines, except, perhaps, for short and easy pieces of work, where its lightness and simplicity might be advantageous. With regard to the apparatus of the other five competitors, the committee are satisfied that any one of them might be of the utmost value for use in mine accidents, where access to the workings was prevented by their being filled with irrespirable gases. They would be valuable alike for the rescue of human life, and also for carrying on such operations as might be required; for instance, the construction of a wall to cut off part of a mine which was on fire, or the closing of a door to alter the direction of the air-current.

It must be borne in mind that the use of any apparatus of this sort must of necessity be limited by various considerations. The apparatus requires to be known by the person using it, and it can only be usefully employed by a man having a certain amount of experience in its use and a certain amount of practical skill. The distance to which the wearer can travel is also limited. There is no doubt that the physical exertion involved in making one's way through passages of a mine, probably blocked up by the fall of *débris* and other obstacles, in almost entire darkness, and under conditions involving very great mental strain, must of necessity be very considerable.

The five apparatus considered all vary in construction; each of them possesses details in which it is superior to the rest. It is probable that in the future some apparatus may be constructed embodying the advantageous points of all of them, and avoiding the defects. The principal points of difference, apart from the fundamental principles on which the apparatus are constructed, appear in the comparative lightness and convenience of carriage, and in the arrangements for enabling the wearer to breathe either by the use of a helmet, or by means of mouthpieces of various construction.

The committee do not consider that the liquid-

air apparatus sent in is as yet sufficiently perfect to justify its adoption in preference to the older systems, under which oxygen is supplied from a receptacle containing the gas in a state of compression. Liquid air, although, perhaps, it can in the future be obtained in sufficient quantities, and with sufficient readiness, is not easy to store; and it is probably hardly possible to avoid very great waste. Other points are the extreme cold produced by its evaporation, and the difficulty of properly regulating this evaporation. But the apparatus is one of the highest interest, and it is to be hoped that its development will be continued.

The committee have found a difficulty in reaching the conclusion that any of the other four apparatus is so far superior to the rest as to justify the award of the prize to it, and it alone.

They are, however, of opinion that the apparatus originally invented by Mr. Henry A. Fleuss, and submitted in its improved condition by Messrs. Siebe, Gorman & Co., Ltd., has sufficient points of superiority to justify an award to its inventor. They, therefore, recommend the award of a gold medal to Mr. Henry A. Fleuss, who as long ago as 1883 received a gold medal from the Society of Arts, under the Shaw Trust, for this apparatus in its original form. The fact that Mr. Fleuss was certainly one of the first to propose, and the first to bring into practical form, an apparatus of this type, has had very great weight in the decision at which the committee have arrived.

They also wish to recommend to the Council that they should award a second gold medal to Mr. William Edward Garforth, in recognition of his long-continued and public-spirited endeavours to perfect and to secure the adoption in this country of rescue apparatus in mines, and also as an acknowledgment of the merits of the principles which he has applied to the apparatus he has himself devised, but which are equally applicable to all similar forms of rescue apparatus.

In addition to these two gold medals, the committee recommend to the Council the award of a silver medal for the Draeger apparatus submitted by Mr. Jacobson, and for the Meco apparatus submitted by the Mining Engineering Company of Sheffield.

They believe that any of the four apparatus would be efficient, each of them having its own points of merit; and, as before observed, the perfect apparatus, if it is ever constructed, will probably include features derived from all of them.

THE ROYAL SOCIETY OF ARTS.

By Sir Henry Trueman Wood, M.A.,
Secretary of the Society.

II.—The Earliest Lists of Members.

It was some little time before the ideas started by Shipley and his patrons really got hold of the public. At first no special efforts seem to have been made to obtain subscriptions and attract public support. From the date of the first meeting till the constitution of the Society, nearly a year later, only seventeen members were enlisted. In the first two months after the election of officers in February, 1755, the number was raised to eighty-one, and after that the increase was fairly rapid.

The most interesting record of these early days is an ancient signature-book, which, according to its titlepage, was a "List of the Nobility, Clergy, Gentry, Merchants, etc., who have subscribed towards raising a Fund for the Encouragement of Arts, Manufactures, and Commerce, 1754." The signatories of the book bound themselves by the undertaking: "We promise to pay annually during pleasure the several sums to which our names are respectively prefixed."

This seems to have been the original form of the list of members, and as it contains the autographs of a very large proportion of the distinguished persons who from the first supported the young Society, it is really a document of very great value, even though a considerable proportion of the members never signed it at all. Some of the more interesting signatures have been reproduced in facsimile, and a selection from these is given on pages 790–792. The book remained in use as a signature-book for about ten years, but in 1755 a regular register was started, with the names and addresses of members, the amounts of their subscriptions, the dates when they became due, and the dates of their deaths or resignations. The first volume of this register contains the elections from 1755 to 1767, and it has been continued, almost in the same form, up to the present date. Then, as now, the book lasted for about ten years, and at the end of that time a fresh book had to be opened, the names of surviving members being transferred, and space provided for the receipt of new entries.

The first printed list of members was issued in October, 1755. It is a mere broadside, and contains 110 names. The next list which has been preserved is dated 1758, in which year the numbers increased to 708, and the next following 1760. From that date they go on regularly at

short intervals, until their regular annual publication. A careful examination of these lists affords very remarkable evidence of the popularity of the Society, of the way in which it rapidly attracted public support, and of the esteem in which it was held. A very large proportion of the peerage supported the Society with contributions and patronage. Men of distinction in every class of life subscribed, and there is hardly any class or rank without eminent representatives. When it is borne in mind that the whole object of the Society was the promotion of public welfare, and that not the slightest advantage or benefit was offered to individual members, the character of the list seems still more remarkable.

"As the condition of England in the middle of the seventeenth century brought about the foundation of the Royal Society and the popular and widely-spread interest in the investigation of science, so the condition of the country in the middle of the eighteenth century brought about the formation of the Society of Arts for the encouragement of the applications of science for the general good. As Dryden, Waller, Evelyn, and the literary coterie of the Restoration period largely supported the Royal Society, so the circle that surrounded Dr. Johnson took a lively interest in the success of the Society of Arts. The lines upon which the Royal Society were founded were not followed by the founders of the Society of Arts. The latter made an entirely new departure and were strictly original in their scheme. Their objects were national, and the members gave their money and their time not for their own private advantage, nor for the increase of their personal knowledge, but in an attempt to raise the productive powers of the nation itself."*

To justify these statements it seems worth while to give a selection of the most eminent names which are to be found in the lists of the Society's members for the first ten years of its existence. The latest list examined is that dated March, 1764.

The following may be taken to be a fairly complete list of the Peers whose names are given in one or other of the lists above mentioned. Many of the Peerages are extinct or have passed to the holders of other titles, and no doubt some may have been overlooked. The holders of courtesy titles have not been included, and it would be too much to hope that some mistakes have not been made in identifying individuals:—

Peregrine Bertie, (3rd) Duke of Ancaster. Raised a regiment of foot in the 1745 rebellion. Lord Great Chamberlain of England. The Dukedom became extinct on the death of his brother, the 5th Duke.

John, (4th) Duke of Argyll. He married the beautiful and witty Mary Bellenden.

John, (4th) Duke of Bedford. English Minister-Plenipotentiary at negotiations for Peace of Paris, 1763.

William, (4th) Duke of Devonshire. First Lord of the Treasury, 1756–7.

Augustus, (3rd) Duke of Grafton. He held various offices, and was the nominal head of the Chatham Administration, 1766.

Evelyn, (2nd) Duke of Kingston. He married the notorious Elizabeth Chudleigh, Countess of Bristol, who was afterwards convicted of bigamy.

George, (4th) Duke of Manchester. He was elected in 1761, when he was Viscount Mandeville. He became Duke in 1762.

George, (4th) Duke of Marlborough.

John, (1st) Duke of Montagu. Elected as (4th) Earl of Cardigan in 1775, and created Duke in 1766.

William, (2nd) Duke of Portland. When he died in 1762 his successor, William (the 3rd Duke), became a member. The latter was twice Prime Minister in the reign of George III.

Charles, (3rd) Duke of Queensberry. This was the cousin and predecessor of "Old Q."

Charles, (3rd) Duke of Richmond. Ambassador and statesman. In the Cabinet of the younger Pitt. Vice-President of the Society. His portrait appears in Barry's Picture.

James, Marquis of Carnarvon. Eldest son of the 2nd Duke of Chandos. He afterwards became the 3rd Duke, and the title died with him in 1789.

Charles, (2nd) Marquis of Rockingham. Prime Minister, and head of the Rockingham Administration, of which Fox and Burke formed part.

James, (8th) Earl of Abercorn.

Arthur, (7th) Earl of Anglesey. His title to the English Peerage was pronounced invalid.

John, (2nd) Earl of Ashburnham.

William, (2nd) Earl of Bessborough. Postmaster-General, etc.

John, (3rd) Earl of Bute. Prime Minister. He paid £40 as a "perpetual member."

George, (4th) Earl of Cardigan, afterwards (1766) created Duke of Montagu.

Robert, (1st) Earl of Catherlough.

Philip, (4th) Earl of Chesterfield. The celebrated Lord Chesterfield.

Smith, (11th) Earl of Clanricarde.

* H. B. Wheatley's account of the Society of Arts, *Engineering*, July 24th, 1891.

William, (2nd) Earl of Dartmouth.

John, (2nd) Earl of Egmont.

Charles, (2nd) Earl of Egremont.

Brownlow, (9th) Earl of Exeter.

Robert, Earl of Farnham. He was the 2nd Baron Farnham, and was created Earl of Farnham in 1763, but died without male issue, so the Earldom lapsed.

Washington, (5th) Earl Ferrers, younger brother of the notorious Earl Ferrers, who was executed in 1760.

John, (7th) Earl of Galloway. Elected in 1761 as Lord Garlies.

Charles, (1st) Earl Grey. General. Commander-in-Chief in America and the West Indies.

George Montagu, (3rd, and last) Earl of Halifax, K.G. First Lord of the Admiralty, Lord Lieutenant of Ireland, etc.

Simon, (1st) Earl Harcourt. Ambassador and Viceroy of Ireland. His eldest son, George Simon Viscount Nuneham, was also a member. He succeeded his father as (2nd) Earl Harcourt in 1777.

Philip, (2nd) Earl of Hardwicke. Elected when he was Viscount Royston. Vice-President of the Society.

Wills Hill, (1st) Earl of Hillsborough, afterwards (1789) Marquis of Downshire, Statesman.

Robert, (4th) Earl of Holdernesse. Ambassador and Secretary of State.

Francis, (10th) Earl of Huntingdon.

George, (3rd) Earl Lichfield, Chancellor of the University of Oxford, 1762. Vice-President of the Society.

John, (1st) Earl Ligonier. Field-Marshal. He served under Marlborough in Flanders, and received several steps in the Peerage, becoming Earl in 1766. He died in 1770 at the great age of ninety-one, and was buried in Westminster Abbey.

Henry, (9th) Earl of Lincoln, afterwards (2nd) Duke of Newcastle.

George Parker, (2nd) Earl of Macclesfield. P.R.S. He took an active part in the introduction of the New Style in 1751. Thomas, the 3rd Earl, was also a member. He was elected in 1757 as Viscount Parker.

Charles Henry, (7th) Earl of Montrath.

James, (8th) Earl of Moray.

Charles, (7th) Earl of Northampton.

Spencer, (8th) Earl of Northampton.

Hugh Smithson, Earl of Northumberland. Elected under that title in 1757. He was in 1766 created the 1st Duke of Northumberland.

Henry Herbert, (10th) Earl of Pembroke.

Other, (4th) Earl of Plymouth.

George, (2nd) Earl of Pomfret.

Henry Arthur, Earl of Powis (Lord Herbert of Cherbury). The extinct Earldom, after the death of his son, was conferred on the eldest son of Lord Clive.

Neil, (3rd) Earl of Rosebery.

John, (4th) Earl of Sandwich. The famous First Lord of the Admiralty, the inventor of the sandwich, which he ate when too busy for a meal. Known as "Jemmy Twitcher," from the character in the "Beggar's Opera," in consequence of his attack upon Wilkes, his former friend and associate at Medmenham Abbey.

Antony, (4th) Earl of Shaftesbury. He married a daughter of Lord Folkestone, and was one of the first subscribers, having given ten guineas to the original fund started in 1754 to provide prizes.

William, (2nd) Earl of Shelburne, Prime Minister in George III.'s reign, afterwards 1st Marquis of Lansdowne.

Harry, (4th) Earl of Stamford.

Philip, (2nd) Earl of Stanhope, the father of the Earl Stanhope who improved the printing-press.

Earl of Stirling. This was William Alexander, "Commander-in-Chief of the American forces," who claimed and bore the title after the death of the 5th Earl in 1739. He died in 1795.

Granville, (2nd) Earl of Sutherland, afterwards Marquis of Stafford.

Richard, (1st) Earl Temple, brother of the Prime Minister George Grenville.

Percy, (1st) Earl of Thomond.

John, (2nd) Earl Tylney. He was the grandson of Sir Josiah Child, the great merchant and economist, chairman and for long absolute ruler of the East India Company.

Ralph, (2nd) Earl Verney, F.R.S. At his death, in 1791, the title became extinct.

James, (2nd) Earl of Waldegrave, K.G. First Lord of the Treasury.

Francis Greville, (1st) Earl of Warwick. He was the 8th Baron, and first Earl Brooke.

Thomas, (8th) Earl of Westmorland. His eldest son, John, Lord Burghersh, was also a member. He succeeded his father in 1771 as (9th) Earl of Westmorland.

William, (2nd) Viscount Barrington, Chancellor of the Exchequer, etc.

John, (2nd) Viscount Bateman.

Frederick, (2nd) Viscount Bolingbroke.

James, (3rd) Viscount Charlemont, afterwards Earl of Charlemont.

Henry, (1st) Viscount Conyngham.

William, (2nd) Viscount Courtenay. The title became extinct with his son, who, however, had established his title to the Earldom of Devon.

John, (4th) Viscount Downe.

John, (1st) Viscount Dudley.

Lucius, (7th) Viscount Falkland.

Richard, (6th) Viscount Fitzwilliam.

Jacob, (1st) Viscount Folkestone. Founder and First President of the Society. His portrait by Gainsborough is in the possession of the Society, and Barry also included the portrait in his painting of "The Society."

Richard, (4th) Viscount Howe. The celebrated Admiral Howe, afterwards Earl Howe.

Charles, (9th) Viscount Irvine.

Thomas, (4th) Viscount Kenmare.

George, (3rd) Viscount Midleton.

Henry, (2nd) Viscount Palmerston, Father of the well-known statesman.

Edward, (2nd) Viscount Powerscourt.

George, (1st) Viscount Southwell.

John, (1st) Viscount Spencer, afterwards (1765) Earl Spencer. His son was the founder of "the finest private library in Europe," and the well-known statesman.

George, Viscount Townshend, the 4th Viscount and 1st Marquis. Field-Marshal, Lord-Lieutenant of Ireland, Brigadier-General under Wolfe in Quebec Expedition. He was elected in 1757 as General Townshend, before his accession to the Peerage.

Thomas, (2nd) Viscount Wentworth. His father, the 1st Viscount, was elected a member before his promotion, and his name appears in the list as Baron Wentworth.

Thomas, (3rd) Viscount Weymouth, K.G., afterwards (1789) created Marquis of Bath. Secretary of State and Lord-Lieutenant of Ireland.

George, (1st) Baron Anson. The great Admiral, First Lord of the Admiralty. Celebrated for his voyage round the world. He had no children, so his title died with him.

Frederick, (7th) Baron Baltimore. At his death the title became extinct. The first Lord Baltimore was the coloniser of Maryland in the reign of James I., and it was from him that the city of Baltimore took its name. Barry heard of Baltimore's charter to the Indians after he had finished the picture in the meeting room. So in his etching he made Baltimore a prominent figure, and thrust William Penn into the background.

Charles, (3rd) Baron Cadogan, afterwards (1800) created Earl Cadogan.

John, (1st) Baron Carysfort. Lord of the Admiralty.

Robert, (1st) Baron Clive of Plassy. The great Indian statesman and General.

Gabriel, (1st) Baron Coleraine.

Richard, (2nd) Baron Edgcumbe. He died in the year following his election, 1761, when his brother and successor became a member.

George, (3rd) Baron Edgcumbe, created Earl of Mount-Edgcumbe in 1789.

Thomas, (1st) Baron Foley.

George, (1st) Baron Lyttelton, scholar and author.

Thomas, (2nd) Baron Montfort.

Frederick, Lord North, afterwards (1790) 2nd Earl of Guilford. The eminent statesman, Prime Minister 1770 to 1782.

Francis, (1st) Baron Orwell, afterwards (1776) Viscount Orwell and (1777) Earl of Shipbrook.

John, (1st) Baron Pollington, afterwards Earl of Mexborough.

George, (1st) Baron Rodney, the great Admiral. He was elected in 1757 as Admiral Rodney, and was made a peer in 1782.

Robert, (2nd) Baron Romney. Founder, first Vice-President, and second President of the Society. His portrait by Reynolds is in the possession of the Society.

John, (11th) Baron St. John of Bletsoe.

Nathaniel, (1st) Baron Scarsdale.

Thomas, (3rd) Baron Southwell, created Viscount Southwell in 1776.

John, (1st) Baron Waltham.

John, (6th) Baron Ward, afterwards (1763) Viscount Dudley and Ward.

Edward, Baron Wentworth, afterwards (1762) (1st) Viscount Wentworth. His son was also a member, and his name is included among the Viscounts.

John, (6th) Baron Willoughby de Broke.

Hugh, (15th) Baron Willoughby de Parham. P.S.A., F.R.S., Vice-President of the Society.

Edward, (1st) Baron Winterton, afterwards (1766) Earl Winterton.

We may now leave the Peerage, and attempt a selection from the general body of members, dealing as before with the lists previous to, and including that of, 1764. The task of picking out the names of persons eminent at the time or afterwards distinguished has proved rather difficult. Without the help of that admirable work, the "Dictionary of National Biography," it would have been hopeless. Wider historical

knowledge, and a greater familiarity with the records of the time would, no doubt, have rendered the task easier and the results more complete. In many cases, also, the information given is too slight to render identification certain. The list, therefore, must be taken as representative rather than exhaustive, though probably there are not many names of real eminence that have been overlooked. At all events, the following list is so long that perhaps no apology is needed for not making it longer.

Robert Adam (elected in 1758) and James Adam (1763), the architects of the Adelphi. (The William Adam elected in 1762 was not one of the brothers.)

Anthony Addington, M.D., physician to the great Lord Chatham and father of the Prime Minister who was nicknamed "The Doctor," in allusion to his parentage.

Ralph Allen, philanthropist, improver of the Post Office, friend of Pope, Fielding, and others.

William Almack, founder of Almack's Assembly Rooms and of the gaming club afterwards known as Brooks's.

John Julius Angerstein, whose fine collection of pictures formed the nucleus of the National Gallery.

Thomas Arne, the well-known musician; composer of "Rule Britannia."

Robert Arthur, St. James's Street, proprietor of Arthur's and White's.

Thomas Astle, antiquary, Keeper of the Records, author of "Origin of Writing."

John Astley, portrait painter, and friend of Horace Walpole.

David Erskine Baker, author of "Companion to the Playhouse," enlarged to "Biographia Dramatica."

Henry Baker, F.R.S., naturalist and author. Defoe's son-in-law. Founder of the Bakerian lecture of the Royal Society. He took a very active part in the foundation and early organisation of the Society. He was elected a "perpetual member" in 1755 for his services.

Samuel Baker, founder of Sotheby's Auction Rooms.

Sir Joseph Banks, for forty-one years the autocratic President of the Royal Society.

Sir Francis Baring, founder of Baring Brothers and Chairman of the East India Company.

Robert Barker, the reputed inventor of panoramas.

Sir Edward Barry, physician, medical writer.

John Baskerville, the eminent printer.

Topham Beauclerk, the fashionable friend of Dr. Johnson.

William Beckford, Lord Mayor 1762 and 1769, the staunch supporter of Wilkes.

Jeremiah Bentham, the father of Jeremy Bentham, the great utilitarian philosopher. He was elected in 1755, when his son Jeremy was sixteen.

James Boswell, elected in 1760 when he was twenty, on his first visit to London and before he knew Johnson.

Alderman John Boydell, the reviver of English engraving by his munificent patronage.

Gustavus Brander, F.R.S., antiquary, director of Bank of England, benefactor to British Museum. One of the Society's founders.

Owen Salusbury Brereton, antiquary, Recorder of Liverpool, Bencher of Lincoln's Inn. Vice-President of the Society. His portrait is in Barry's picture.

Jacob Bryant, classical scholar.

Charles Burney, the well-known author of the "History of Music." He was elected in 1764, when he was living in Poland Street, and before he took the degree of Mus.Doc. His portrait appears in Barry's picture, "The Thames," amongst the sea-nymphs, "a whim equally absurd and incomprehensible, which no raillery or good counsel could induce" the artist "to dismiss from his canvas."

William Cadogan, M.D., physician to the Foundling Hospital.

William Caslon, the famous type-founder.

The Hon. Henry Cavendish, the great philosopher and experimentalist.

Sir Robert Chambers, one of the judges in the trial of Nuncomar.

Sir William Chambers, the architect of Somerset House. He acted as architect to the Society when it moved into new premises in Little Denmark Court, 1759.

Samuel Chandler, D.D., Nonconformist minister and bookseller.

Charles Chauncey, physician and collector.

Sir Henry Cheere, statuary, patron of Roubiliac.

Thomas Chippendale, furniture maker.

Giovanni Cipriani, R.A., historical painter and engraver.

George Colman the elder, dramatist.

Sir Eyre Coote, the famous Indian General and conqueror of Hyder Ali. At the time of his election he was Colonel Coote.

Richard Cosway, R.A., portrait painter.

James, Thomas, and Patrick Coutts. James at the time of his election was already a partner in the great banking firm, then in the "New

Exchange," and carrying on business as "Campbell and Coutts." Thomas was elected in 1762, the year after he had been taken into partnership, after the death of Campbell. Patrick was at the time of his election (1767) a partner in the bank in St. Mary Axe, first started by the Coutts.

Sir John Cust, Speaker of the House of Commons, 1761 and 1768–70.

George Dance, the elder of the two architects, father and son. He designed the Mansion House.

Sir Francis Dashwood (Baron le Despencer), Chancellor of the Exchequer, and leading member of the Dilettanti Society; founder of the "Hell Fire Club" at Medmenham.

Captain (afterwards Colonel) Thomas Desaguliers, F.R.S., son of J. T. Desaguliers, author of various books on mechanical and experimental philosophy.

Sir Alexander Dick, president of the Edinburgh College of Physicians and friend of Dr. Johnson.

Robert and James Dodsley, the well-known booksellers.

John Dollond, the eminent optician, Copley medallist.

Robert Dossie, the editor of the "Annals of Agriculture," etc., in which the Society's early Proceedings were recorded. He was a friend of Samuel Johnson, and the Doctor, being in arrears with his subscription, paid up in order to vote for Dossie when he was a candidate for the secretaryship of the Society in 1760.

Robert and John Drummond, the bankers, whose bank was then, as now, at Charing Cross, were both members. The former was elected in 1757 and the latter in 1762. Robert, who was the head of the firm, was the son of Viscount Strathallan, who was killed at Culloden and was attainted, as was also his eldest son. John married a granddaughter of the first Duke of St. Albans (Nell Gwynne's son), and it was through this connection that the Adelphi estate, acquired by the second Duke of St. Albans, on his marriage with the daughter of Sir John Werden, whose Trustees had purchased it, came into the possession of the Drummond family. The Drummonds have ever since been connected with the Society; and Mr. George James Drummond, the owner of the Adelphi, is now (1911) the Society's landlord. The bank was founded in 1688 by Andrew Drummond, the father of John, abovementioned.

Sir John Fielding, the magistrate, half-brother to the novelist.

Sir Samuel Fludyer, Lord Mayor in 1761. Fludyer Street, Westminster, was called after him.

John Fothergill, M.D., F.R.S., botanist and physician, associated with Franklin.

Benjamin Franklin, the great American philosopher and politician. He was elected a corresponding member in 1756, but paid the amount of a Life Subscription, and his name afterwards appears among the ordinary members. He kept up a correspondence with the Society, and in 1761, while in England, he accepted the office of chairman of the Committee of British Colonies and Trade.

David Garrick, the great actor.

Edward Gibbon, the historian.

Thomas Gisborne, M.D., President of the College of Physicians.

Oliver Goldsmith, whose address when he was elected in 1763 was the Chapter Coffee House.

Major-General Sir John Griffin, K.B., afterwards Field-Marshal, and (1784) (9th) Baron Howard de Walden.

Admiral Thomas Griffin, served in the West Indies and elsewhere, but left an unfortunate reputation for lack of intrepidity and for unpopularity.

Thomas Grignion, the clockmaker, who presented to the Society the clock in the meeting-room.

Francis Grose, antiquary and author.

Stephen Hales, D.D, F.R.S., Copley Medallist, physiologist, botanist and inventor. One of the Society's founders. His portrait is in Barry's Picture of "The Society."

Jonas Hanway, the historian of commerce and the introducer of umbrellas.

Sir Charles Hardy, Admiral, Governor of New York, served in command under Hawke at Brest and Quiberon Bay. M.P. for Portsmouth.

The Hon. Thomas Harley, afterwards Lord Mayor (1767), opponent of Wilkes.

Sir Edward Hawke, K.B., the distinguished Admiral, afterwards (1776) 1st Baron Hawke.

John Hawkesworth, LL.D., friend of Johnson, and his successor as compiler of the Parliamentary reports in the *Gentleman's Magazine.*

Sir Cæsar Hawkins, the eminent surgeon.

Sir George Hay, lawyer and politician.

Francis Hayman, original R.A., friend of Hogarth and Garrick.

William Heberden (the elder), physician and scholar; attended Johnson, Cowper and

Warburton. He, like Cæsar, wrote his "Commentaries," and a bookseller is said to have recommended one as a substitute for the other.

William Hoare, of Bath, original R.A. Distinguished portrait-painter.

William Hogarth. His signature is crossed out in the signature book; why, there is no saying. He was duly elected in December, 1755, and subscribed for two years. His name appears on committees in 1757. He died in 1764.

Thomas Hollis, republican and author. Presented portrait of Newton to Trinity College, Cambridge, and portrait of Cromwell to Sidney Sussex.

John Howard, the philanthropist.

Richard Huck, army surgeon and physician of reputation. In 1777 he took the additional name of Saunders.

Dr. William Hunter, the physician, who was as well known in his day as his younger brother John.

Dr. Robert James, the inventor of James's Powder.

Richard Jebb, M.D., afterwards (1778) baronet. Friend of Wilkes and Churchill.

Soame Jenyns, a great man in his day, but now best known as having had his "Nature and Origin of Evil" unfavourably reviewed by Johnson.

Samuel Johnson, whose only speech on his legs is said to have been delivered in the meeting-room of the Society of Arts.

Hugh Kelly, a playwright who considered himself a rival of Goldsmith.

Admiral Augustus Keppel, afterwards (1782) created Viscount Keppel.

Gowin Knight, M.D., F.R.S., Principal Librarian of the British Museum.

Sir Charles Knowles, Admiral, Governor of Louisburg and of Jamaica.

Abraham Langford, auctioneer and playwright.

Colonel Stringer Lawrence, called the "father of the Indian Army." He left India in 1759.

Thomas Lawrence, friend and physician of Dr. Johnson.

Sir Wilfrid Lawson, the eighth Baronet.

Henry Bilson-Legge, Financier, Chancellor of the Exchequer, etc.

James McArdel, one of the best English mezzotint engravers.

Robert Mackreth, the well-known waiter at Arthur's Chocolate House, known as "Bob," afterwards M.P., and knighted.

Sir Richard Manningham, known as a great "man-midwife."

William Markham, D.D., headmaster of Westminster School; afterwards (1777) Archbishop of York.

Matthew Maty, M.D., F.R.S., secretary R.S., Principal Librarian of the British Museum. He was a candidate for the secretaryship of the Society in 1760, when Dr. Templeman was elected.

Israel Mauduit, F.R.S., political pamphleteer and preacher. Agent in England for Massachusetts.

John Mitchell, F.R.S., botanist, made a map of the British and French Dominions in North America.

Sir Henry Moore, Bart., Governor of Jamaica and of New York.

Robert More, F.R.S., botanist. Afterwards secretary of the Society (1769 to 1799).

Charles Morton, M.D., Principal Librarian of the British Museum.

George Michael Moser, chaser and enameller, first keeper R.A. Engraved George III.'s first Great Seal. Father of Mary Moser, R.A.

Lieut.-Gen. Lord John Murray, M.P. for Perth.

Robert Mylne, F.R.S., constructed Blackfriars Bridge, engineer to the New River Company.

John Newbery, publisher and bookseller. He employed Johnson and Goldsmith.

Frank Nicholls, F.R.S., physician.

Lieut.-General Oglethorpe, M.P., founder of Georgia. Johnson offered to write his life. Austin Dobson calls him a "Paladin of Philanthropy."

James Paine, an architect who did much good in his time. He rebuilt Salisbury Street in 1783.

Sir Robert Palk, Bart., Governor of Madras. Palk Strait, between Ceylon and India, is called after him.

James Parsons, M.D., F.R.S., physician and antiquary.

Sir Lucas Pepys, Bart., M.D., President Royal College of Physicians, physician to George III. Attended the King in his insanity. He was elected in 1764, when twenty-two years of age.

John Lewis Petit, M.D., F.R.S., physician.

Constantine John Phipps, commanded the "Racehorse" in expedition of 1773 to discover north-eastern route to India, and attained a high north latitude to north of Spitzbergen. Afterwards (2nd) Baron Mulgave, M.P., and Lord of the Admiralty, etc.

Christopher Pinchbeck, inventor, son of the inventor of copper and zinc alloy named after him.

Charles Pinfold, Governor of Barbados.

Thomas Pingo, medallist, assistant engraver to the Mint.

William Pitcairn, M.D., President of the College of Physicians, 1775–85. A ward in St. Bartholomew's Hospital is named after him.

George Pitt, afterwards Baron Rivers, author of "Letters to a Young Nobleman," etc.

William Pitt, the great statesman, afterwards Earl of Chatham.

Admiral Sir George Pocock. He took Havana in 1762.

Sir James Porter, F.R.S., Ambassador at Constantinople.

Governor Pownall, politician. His work on "The Administration of the Colonies" went through several editions. He was elected in 1760, and his name in the List is altered from "Governor" to "Thos, Esq."

Sir Charles Pratt, afterwards created Earl Camden, Lord Chancellor and Chief Justice; decided in the case of John Wilkes that general warrants were illegal, and thereby gained immense popularity.

William, Viscount Pulteney, the son of the well-known politician who was made Earl of Bath by Walpole. He died before his father, and the earldom became extinct.

Sir Thomas Pye, Admiral. "A man of slender ability, thrust into office by the Bathurst influence."—*Dict. Nat. Biog.*

Allan Ramsay, portrait painter to George III., acquaintance of Johnson.

Sir Joshua Reynolds, first President of the Royal Academy. Elected in 1756 before he was knighted.

General Robert Rich (afterwards 5th baronet), wounded at Culloden.

Samuel Richardson, the novelist.

Sir Thomas Robinson, Governor of Barbados and Commissioner of Excise.

John Robison, went to Jamaica for the test of Harrison's chronometer.

Francis Louis Roubiliac, the sculptor.

Sir John St. Aubyn, (5th) Bart., M.P., F.R.S.

Lord George Sackville, afterwards Viscount Sackville, of unhappy reputation for his behaviour at the battle of Minden in 1759.

Paul Sandby, R.A., water-colour painter and engraver.

Sir Charles Saunders, K.B., Admiral, served on Newfoundland station, and First Lord of the Admiralty.

Sir George Savile, Bart., M.P., F.R.S., well-known independent politician, and Vice-President of the Society.

Gregory Sharpe, D.D., F.R.S., Master of the Temple.

Peter Shaw, physician and author.

Thomas Sheridan, author and actor (father of Richard Brinsley). Proposed by Garrick.

The Rev. Laurence Sterne, author of "Tristram Shandy."

John Stock, painter to His Majesty's dockyards. He died in 1781, leaving the bulk of his property, upwards of £60,000, to the Painters' Company, with instructions that the interest should be distributed to the aged blind, the poor of the Company, and others. He left £100 to the Society, with the condition that the interest should be applied for the promotion of drawing, sculpture, and architecture.

Sir Robert Strange, the eminent English engraver.

General William Strode. It was he who erected the statue of Queen Charlotte in the centre of Queen's Square, and that of William, Duke of Cumberland, in Cavendish Square.

James Stuart, author, member of the Dilettanti Society, generally known as "Athenian" Stuart.

George Stubbs, the well-known animal painter.

Robert Taylor, M.D., F.R.S., a well-known physician.

James Theobald, F.R.S., F.S.A. One of the first Vice-Presidents of the Society. He took an active part in the movement for obtaining a charter for the Society of Antiquaries. He died in 1759. He is mentioned several times in Nichols's Literary Anecdotes, but is ignored by the *Dict. Nat. Biog.*

Sir Noah Thomas, M.D., F.R.S., physician.

Bonnell Thornton, well-known wit and writer, member of the "Nonsense Club," which organised an "Exhibition of the Society of Sign-painters," in ridicule of the Society of Arts Exhibition (see "Dictionary of National Biography"). He only subscribed for one year, so perhaps the Society's methods did not commend themselves to him.

John Thornton, one of the first of the well-known Clapham family, the great evangelicals.

Henry Thrale, the brewer, Johnson's friend.

Jacob Tonson, great nephew of Jacob Tonson, Dryden's first publisher, employed Warburton and Johnson among others.

Rev. James Townley, headmaster of Merchant Taylors' School, author of "High Life below Stairs," friend of Hogarth.

Charles Townshend, Chancellor of the Exchequer, etc., and brilliant wit.

Jonathan Tyers, proprietor of Vauxhall Gardens.

Robert Vansittart, Regius Professor of Civil Law, Oxford.

Horace Walpole, the great connoisseur and well-known author and collector. Afterwards (1791) 4th Earl of Orford.

Joshua Ward, "Spot" Ward, the well-known quack and nostrum-monger, whose statue by Agostino Carlini decorates the Society's Hall. He acquired a fortune by the sale of pills and potions, and a reputation by his introduction of improved methods of making sulphuric acid.

Richard Warren, M.D., a well-known physician.

Sir William Watson, M.D., F.R.S., physician and man of science. Physician to Foundling Hospital.

Philip Carteret Webb, F.R.S., M.P. He was joint solicitor to the Treasury and a leading official in prosecution of John Wilkes.

Alexander Wedderburn, Lincoln's Inn, afterwards Lord Loughborough and Earl of Rosslyn.

Saunders Welch, a magistrate of Westminster, friend of Fielding and Johnson.

Benjamin West, R.A., the painter.

Samuel Whitbread, brewer, father of the better-known politician.

Caleb Whitefoord, wit and diplomatist. Friend of Franklin, Johnson, Goldsmith, and Horace Walpole. He was a Vice-President of the Society, and a very active member of it. He was instrumental in obtaining the portraits of Shipley and Templeman. The Society possesses his portrait by an unknown painter.

Charles Whitworth, M.P., Chairman of Ways and Means, 1774 to 1778. Knighted 1768. One of the first Vice-Presidents of the Society.

John Wilkes, elected 1758 when thirty-one years of age. He was proposed by his father Israel Wilkes, who joined the Society in 1757, and was a very active member, constantly taking the chair at committee meetings.

Sir Edward Wilmot, Bart., M.D., F.R.S. Physician General to the Army.

Sir John Eardley-Wilmot, Chief Justice, Common Pleas. Educated with Johnson at Lichfield.

Joseph Wilton, sculptor, foundation member of R.A., associated with Sir William Chambers, the architect.

Henry Sampson Woodfall, the printer of the "Letters of Junius," and conductor of the *Public Advertiser*.

Sir George Yonge, Bart., Governor of the Cape.

Christian Friedrich Zincke, enamel painter; produced many portraits in enamel.

Amongst the names which came up for election there were very few rejected, as would naturally be the case when the object of the Society was to collect subscriptions for a certain purpose. However, one was that notorious free-lance, Dr. John Hill, or Sir John Hill, as he called himself after he had been made a knight of the Order of Vasa by the King of Sweden. He was proposed for election, but was unsuccessful, as he also was when he tried to get into the Royal Society, so that he might put F.R.S. after his name in the titlepage of one of his books. The "Dictionary of National Biography" describes Hill as "a versatile man of unscrupulous character, with considerable abilities, great perseverance, and unlimited impudence." He appears to have been at loggerheads with all his contemporaries. He paid out the Royal Society for not admitting him by an attack upon them, which certainly found out some of the weak joints in the armour of that distinguished body. He tackled Fielding and got rather the worst of it. When Garrick spoke slightingly of a play written by him, he attacked him also. Garrick retaliated by the well-known epigram :—

> "For physic and farces his equal there scarce is,
> His farces are physic, his physic a farce is."

He does not appear to have been much affected by his rejection by the Society of Arts, though he wrote what was for him a temperate letter of protest.

From the first foundation of the Society ladies have been eligible for membership, and the lists of Members have always contained a certain number of women's names. The first list of October, 1755, contains the names of Miss Elizabeth Vaughan and Lady Betty Germain, daughter of the Earl of Berkeley, wife of Sir John Germain, who came with William the Third to England and served under him. She inherited a large fortune from her husband, and bequeathed it, in accordance with his desire, to Lord George Sackville, who took the name of Germain. She was a friend of Swift and other literary men. Miss Mary Cook—who, like Miss Vaughan, is now but an unknown name to us—was elected a little later in the same year (1755), and Mrs. Elizabeth Montagu—whose name is spelt Mountague in the list—the earliest "blue stocking" and the well-known authoress and leader of intellectual society, became a member in 1758. Her portrait appears in Barry's picture of the Society. Later lists include the names of the Countess of Denbigh, the Countess of

Macclesfield, the Countess of Northumberland, and Viscountess Falmouth.

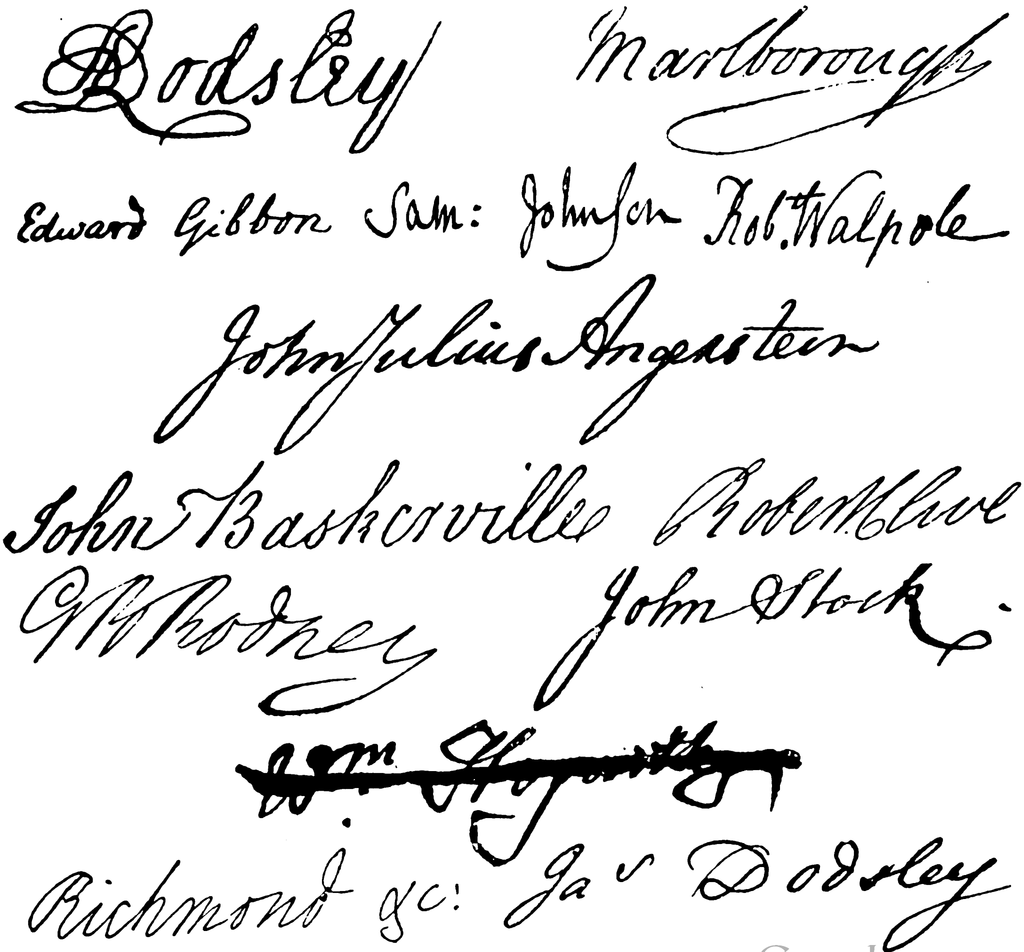
There can be no doubt that the list from which the above names have been selected was a very remarkable one, and one which may challenge comparison with that of any other society, however distinguished. Statesmen, philosophers, philanthropists, painters, lawyers, divines, physicians, authors, dramatists, actors, musicians, bankers, soldiers, sailors, architects, historians, mechanicians, merchants, all are to be found, and many of them are the most eminent of the time. Besides these, there is a crowd of peers and wealthy men who seem to have been quite ready to support, with their purses and their influence, a scheme which commended itself as likely to promote the growing industrial and commercial interests of the kingdom.

Other evidence as to the early popularity of the Society, and of the public esteem in which it was held, is to be found in contemporary literature. Smollett, in his History* gives a full and laudatory account of the institution and proceedings of the Society: "The protection, countenance and gratification secured in other countries by the institution of academies, and the liberalities of princes, the ingenious in England derived from the generosity of a publick, endued with taste and sensibility, eager for improvement, and proud of patronizing extraordinary merit. . . . In a word, the Society is so numerous, the contributions so considerable, the plan so judiciously laid, and executed with such discretion and spirit, as to promise much more effectual and extensive advantage to the publick than ever accrued from all the boasted academies of Christendom."

Anderson, in his "History of Commerce,"* speaks of the Society as: "One of the noblest designs for the improvement of the Commerce of Great Britain which could possibly have been devised." Perhaps in both cases the laudation is a little exaggerated, but the quotations may serve to show the estimation in which the early efforts of the Society were held.

* Book III. Ch. x. § iv.

* Vol. III., p. 298.



Stephen Hales Tho: Pingo Kingstone

Shaftesbury Saml. Richardson.

Wm Chambers

Folkestone

Isaac Worcester. Temple

Romney

John Peterborough John Wilkes

Cardigan

Stanhope

Macclesfield

Plimouth Tho: Anson

Verney

Lichfield Jno Newbery

Stanhope

Waymouth Joshua Reynolds

George Colman John Howard

Harcourt

John Fothergill

Queensberry & Dover

Carnarvon

Rockingham

Exeter

Portland

Robt Adam

Topham Beauclerk

Geo: Dance

Powis

Giovambatta Cipriani

Hor Walpole

Jonas Hanway

Tho: Norwich

Baltimore

Thos Chippendale

Pembroke

Francis Hayman

Dartmouth

Allan Ramsay

Egremont

John Boydell

William Shipley
Secretary

THE AGRICULTURAL POSSIBILITIES OF NORTHERN JAPAN.

The agricultural investigations of the Japanese Government have demonstrated that Japanese Saghalien is a good winter wheat country, and that Hokhaido Island (the north sea province) is suitable for the desired extension of the silkworm and rice industry. While it has been demonstrated that various grains can be grown in the above districts, the chief points of interest to foreign manufacturers of agricultural implements, flour-mill machinery, etc., is the fact that in Northern Japan the tendency is towards a more liberal spirit, the conditions being more favourable to changes from ancient methods in farming and other industries. The agricultural areas of Japanese Saghalien are not extensive, the country being mountainous, and until the timber is removed it will be impossible to estimate what proportion of the total area, exclusive of mountain regions, may be ultimately suitable for farming. The bottom lands north from Olomari to Toyohara are among the best in the world. The Japanese experimental farm at Toyohara has demonstrated that many kinds of fruits, vegetables, and grain, such as are cultivated in Canada and Norway, can be successfully grown in Japanese Saghalien. According to the American Consul at Yokohama, the Japanese Agricultural College at Sapporo, in Hokhaido, devotes much attention to fisheries as well as to the up-to-date scientific study of practical farming pursuits, including stock-breeding. A model farm is attached to this college, and about half the cost of maintaining the college is obtained from the college lands and farm products. The president of this college believes that the introduction of modern machinery, and the horse, into Japanese farming industries in Hokhaido, coupled with higher wages, will tend to bring about the adoption of foreign methods. He estimates that 1,000,000 acres are under cultivation in Hokhaido, and that another 1,000,000 acres are being cleared for farming purposes, following closely upon the removal of forests, etc. Of the total area of Hokhaido, 6,000,000 acres are nominally reserved for forests. In rice and silk, coal, timber, wheat, and other grains, apples, potatoes and onions, it is rapidly growing more important.

THE BRAZILIAN COCOA-PALM.

Pernambuco is situated in the centre of the tropical part of Brazil, within which the cocoa-palm grows most luxuriantly. The cocoa-palm seems to be indigenous to the district which extends from the vicinity of Bahia on the south to Parahyba on the north, but it attains its fully luxuriant and most prolific development in the vicinity of Pernambuco. The cocoa-palm is one of the most beautiful and attractive natural adornments of many of the public parks and private gardens of Pernambuco, often attaining a height of from eighty to ninety feet. The trunk is without branches, and the leaves which cluster in a tuft at the top are from fifteen to twenty feet in length. At the base of the leaves the nuts hang in clusters, the number varying from three to fifteen according to the age and condition of the tree. The United States Consul at Pernambuco says that the nut is first planted in its natural state with hull and fibre. At the expiration of about twelve months, or when the plant has reached a height of about three feet, it is transplanted and set out in rows about forty feet apart. If cultivated and irrigated the tree will produce at the end of five years, otherwise it will require about ten years to produce. Although the rainfall within the coast region averages about eighty inches per annum, it all occurs during the months of the rainy season, and often when it is of no service to certain vegetation. The summers are hot and dry, and young plants and trees need to be irrigated. There are two cocoa-nut markets in the city of Pernambuco, one for the green and the other for the mature or dried nuts. The green nuts, which are picked at about the end of five months, and before the real meat of the nut has begun to form inside, are composed entirely of water, which forms one of the principal and most popular beverages of the neighbourhood. The water is non-alcoholic, and when iced is converted into a most savoury refrigerant. Its action is diuretic. When the nut is partially mature the inside is sometimes extracted, and by the use of sugar and some other ingredients is converted into a popular confection. The meat of the dried or ripe nut is used exclusively for food, being usually seasoned and mixed with different provisions for flavouring purposes. The owner of one of the large plantations in Pernambuco has recently stated that he averaged about four shillings net profit per annum from each tree. The greater proportion of the nuts are consumed locally, but a considerable quantity is shipped to Rio de Janeiro and other cities of Brazil, and also to European countries, where the improved facilities for extracting the oil have greatly enhanced their value.

THE MOTHER-OF-PEARL INDUSTRY IN THE SOCIETY ISLANDS.

Mother-of-pearl shells are found on the Pacific coasts of North and South America, in the islands of the Pacific Ocean, in the Philippines, on the coasts of Australia and in the adjacent islands, on the coasts of India, and in the islands of the East Indian Archipelago, in the Persian Gulf, in the Red Sea, and in Zanzibar. In Russia mother-of-pearl is used for ornamenting church vestments, and in Austria for making beautiful articles for personal adornment; in Italy high-relief cameos are carved on mother-of-pearl shells, and in Turkey allegorical and ornamental designs are engraved on large polished shells, which are known as Jerusalem shells. Natives of a number of tropical islands make ornaments of the shells, and in the South Pacific they use mother-of-pearl

fish-hooks, which are so bright that no bait or other lure is necessary. In the colony of Tahiti, mother-of-pearl shells are found chiefly in the Tuamotu (or Low) Archipelago, which embraces the Tuamotu (or Paumotu) and the Gambier Islands, and extends in a south-easterly and north-westerly direction for a thousand miles, the greatest width of this belt of islands being 300 miles. While shells are produced in all the islands, they are found of good quality and in paying quantities in fewer than one-fourth of the lagoons, which are enclosed by the eighty-two islands comprising the Tuamotu Archipelago. The American Consul in Tahiti says that the most productive of the Tuamotu Islands are Mikueru, Takume, Takaroa, and Takapoto, of the first rank; Marokau and Ravehere, of the second rank; and Hao, Motutunga, Manihi and Raroia, of the third rank. Of the Gambier Islands, Mangareva, Akamaru, and Akena produce shells which are large and heavy, but their quality is not very good. The time for the opening and closing of the diving season, which usually lasts from the 1st of May to the 1st of November, and the names of the islands open for the season, are published months in advance in the official journal of Tahiti, together with the regulations to be observed and the penalties for their violation. Before the opening of the season Papeete merchants send to the islands schooners laden with supplies, which are stored in portable houses built chiefly of corrugated iron. The shells in the lagoons are regarded as the property of any natives of the colony who will dive for them, but as almost all the good divers live in the Tuamotus, they reap the profits of the diving season. The hours for diving are from 9 until 2. The diver paddles his canoe out into the lagoon and anchors it, and if he happens to hit upon a good place, he may not move his boat during the five hours. A basket to hold the shells is let down by a rope tied to the boat. On the end of another small rope, also tied to the canoe, is a piece of lead weighing from fifteen to twenty pounds. The diver, who wears only a narrow loin-cloth, places one foot upon the lead, and with the rope between his toes stretches the rope with one hand held against his chest, utters several loud yells to empty his lungs, refills them quickly with pure air, and descends rapidly, feet foremost, to the bottom of the lagoon. He tears the shells from their support, usually a piece of dead coral, to which they are firmly fastened. A good diver will go down from twenty to twenty-five times in the five diving hours. The colony of Tahiti has the best divers in the world. They dive from six to one hundred and twenty feet in their work, and remain under water a minute and a half for the average man, two to two and a half minutes for a good diver, and three minutes for a few exceptional experts. Among the pearl-divers of Ceylon the highest record is said to be one hundred and ten seconds. The shells produced in the Society Islands are of the black-edged variety, and are the best of the kind found in the world. As they are all brought to Tahiti for exportation, they are known in the markets of the world as Tahiti black-edged shells. The dark edge is from a half to three-fourths of an inch in width. The rest of the inside is of a bright pearly appearance, with iridescent hues around a wide border, including the dark edge. The largest shells come from the Gambier Islands, which are only four in number, not counting insignificant islets. A French man of science gives an account of a pair of these shells that measured 11¼ inches in width and 13 inches in length, and weighed twelve pounds, but shells of that size are extremely rare. Local schooners bring the shells in bags or in bulk to Papeete. The work of assorting the shells according to size and quality is done chiefly by native women, who also help men to pack them in strong boxes, with a capacity of about two hundred and twenty-five pounds each. Nearly all of the Tahiti shells are shipped by way of New Zealand to London, which is the world's greatest market for this article of commerce. Among the products exported from Tahiti, mother-of-pearl shells rank second in value, copra holding the first place, and vanilla the third. The quantity of shells exported varies considerably from year to year, the average being about 475 tons annually.

HOME INDUSTRIES.

The State Insurance Bill.—The Government expect that this Bill will be law within three months, but meantime criticism is becoming less restrained and more general. Mr. Lloyd George has met the doctors but he has not come to terms with them, and, unless he does so, the Bill must fail. At Birmingham, last Saturday, he said: "I cannot say that I care very much for this wrangle in the sick room," but is it quite fair to put it in that way? Rightly or wrongly, the doctors believe that if the proposals of the Government as to the terms upon which medical attendance shall be given are carried, medical men will be very unfairly treated, and they make out a strong *prima facie* case. There must be give and take if they are to accept the Bill. They cannot be compelled to work for payment they consider inadequate, and the Act would be a dead letter without them. One of the chief points urged by the British Medical Association is that there shall be an income limit of £2 per week for those entitled to medical benefit. It is understood that Mr. Lloyd George will not listen to this suggestion, but there is surely something to say against the £160 limit of the Bill as it stands. As Dr. Benjamin Brown has pointed out, an unmarried man in a shipyard might easily earn £3 or £4 a week. Some unmarried artizans in certain trades earn a good deal more. Yet as soon as he is ill or unemployed he will get help, if the Bill is unamended, just as a poor labourer with a large family. Can it be seriously said that such a man is fit to be considered an object of charity, or a suitable case for Government help? The average income of the people of England is under £40 a

year, and to subsidise a man with an income of £160 must mean that a great number of really poor people will be taxed to put money into his pockets. It will seem to many that the Bill should only apply to married men, and to them only when their earnings do not exceed a sum considerably less than £160 a year. Take again Clause 51, which provides that no distress or ejectment shall be carried out upon a tenant in receipt of sick pay, and that the landlord who is guilty of such procedure shall be liable to a fine of £50. It is hardly conceivable that Parliament will accept this clause. The small landlord is to forego his rent, but he is not to be excused the payment of rates and taxes on his property, for the reason that his tenant is a recipient of sickness benefit. How the clause would work in many cases is shown very vividly in a letter addressed by Mrs. Millie Richardson to the *Times*. Mrs. Richardson rents a weekly house, and underlets the rooms which she does not occupy to working people. If Clause 51 becomes law, she would have to let a lodger stay in his rooms twelve months if he were very ill without paying her rent, and through all that time she would have to pay her landlord rent. Mrs. Richardson asks how she could pay it. She has a husband and three children to keep, and to work very hard at charing to do this. Can it be seriously contended that Mrs. Richardson has a moral duty to her lodger to give him gratuitous shelter for a year because he is too ill to work, or that it would be anything but gross injustice to require her to do so? Mr. Lloyd George seems to deprecate discussion, but it is obvious that the Bill will have to be fully discussed and widely amended if it is not to work more harm than good.

The "Titanic."—The White Star liner "Titanic" was launched last week, and her sister-ship, the "Olympic," has sailed for New York. The "Titanic" is 882 ft. 9 ins. long over all, or 850 ft. between perpendiculars, her breadth is 92 ft., and her depth, moulded, 64 ft. 6 in. The "Lusitania" has a total length of 785 ft., and breadth of 88 ft. The measurement of tonnage is about 45,000 for the "Titanic," and 32,500 for the "Lusitania," but the actual displacements will be about 60,000 and 38,000 respectively. The "Titanic" and "Olympic" mark a great advance in size and capacity over anything previously built. But they are considerably slower than the great Cunard liners, inasmuch as they are only expected to average 21 knots at sea as against 25 to 26 for the Cunarders. In spite of the much greater tonnage of the new ships, their horse-power will only be about 46,000 as against about 70,000 to 75,000 for the "Mauretania," and they will burn about 500 tons of coal per trip less, which means a saving of over £1 per ton. The "Mauretania" has turbine engines only, the "Titanic" has two sets of reciprocating engines and one low-pressure exhaust steam turbine. The passenger accommodation on the "Titanic" is 2,490, and on the "Lusitania" 2,200. The crews are respectively 856 and 827. It is anticipated that the net earning power per trip of the "Titanic" will be considerably more than that of the "Mauretania," but the latter makes a round trip every three weeks as against one in four weeks for the "Titanic."

English and American Shipbuilding.—The allegation that ship-repairing and even shipbuilding is now being done as cheaply in the United States as in the United Kingdom would seem to be upset by the report of the British Consul-General at New York, who was requested to look into the matter. Repairs, he states, cost from 50 to 75 per cent. more in American than in British yards. The explanation of certain recent contracts which seem to disprove this is that American yards were absolutely depleted of work, and accepted unprofitable prices rather than close and disperse their staffs. A similar explanation is given to account for an American firm having some time ago secured the contract for some Argentine "Dreadnoughts." In offering these low prices they were assisted by specially low prices for plates, as the rolling-mills were equally badly in want of work. It would be strange, indeed, if the United States, under present conditions, had become our rivals in shipbuilding.

Incandescent Gas Mantles.—Not very long ago it was discovered that ramie was much more effective in the construction of incandescent gas mantles than cotton, for whereas in the case of cotton the separate fibres of the yarn employed are closely entangled, in ramie they remain pretty wide apart, and so present a larger glowing surface. Now it is reported that experiments with artificial silk show the fibres of this material maintain their individuality to an even greater extent than ramie, and the mantles themselves are said to be much more elastic, supple, and durable. The Deutsche Gasglühlicht Company of Berlin has been doing a good deal of research work on these lines, and it is said that they intend shortly to place a new mantle on the market, whose essential difference from existing types lies in the fact that it is made of artificial silk. It is claimed for it that it is specially adapted for street lighting, and for all purposes where high-pressure gas is employed.

High-Class Tailoring.—It is usually assumed that a West-End tailor has his own workshop, where his customers' clothes are made under proper sanitary conditions, but this is by no means the general practice. Even where there is a workshop, some of the clothes are sometimes given out to be made in the journeyman tailor's home, which is generally, if not always, in an overcrowded tenement house, or a small lodging in a poor district. Here, in the one living and working room, the clothes are spread out and stitched together. A conference has just been held between the representatives of the Association of London Master Tailors and the London and National Amalgamated Societies of Tailors and Tailoresses. After discussion, the representatives of the employers and

employed both agreed it was in the best interests of the trade that work should be done in workshops provided by the master tailors, and not in the journeymen tailors' private dwellings. But this decision only takes the form of a recommendation. There is to be a ballot of the whole trade on a point which primarily interests the general public, which has the matter in its own hands. It is only necessary to inquire before ordering clothes whether the tailor has his own workshop, and to go elsewhere if he has not. When a master tailor finds he is losing some of his customers he will soon look about for a suitable workshop.

The Birkbeck Building Society.—There is no reason to suppose that the directors of the Birkbeck Building Society have been guilty of any of the malpractices associated with the collapse of certain other well-known institutions. Heavy losses were incurred as a consequence of the run on the Bank last autumn, when over £3,000,000 of deposits were withdrawn, which compelled the Society to sell large blocks of its gilt-edged securities at low prices, entailing heavy losses upon it. Then the general fall in high-class securities has involved the Society in serious losses which have not been adequately provided for, and it was difficult to write down the share-capital in order to make provision for the loss incurred owing to doubt about the *status* of the shares. The share subscriptions are about £1,050,000, but shareholders could at any time ask for the repayment of their capital by handing in their shares, and it is not known whether the shares rank for payment in priority to the deposits, or *pari passu* with the deposits, or after the deposits. The constitution of the Society invited disaster. It got its capital on a building society basis, and its deposits on banking conditions, and it used its funds as if it were a trust company. It employed only 16 per cent. of its funds in cash in hand and with bankers, in money at call, and in short loans and advances to customers, whereas it placed 70 per cent. of its total funds in investments, and about 7 per cent. in mortgage and ground-rents. The shares should not have been repayable, but should have been the margin for the safety of the deposits, and received the profits after meeting expenses and interest, whilst a much smaller proportion of the funds should have been invested in securities, and a much larger proportion in loans to customers and in the discount of bills, so as to secure the means of drawing a larger proportion of the funds if necessary, without requiring to sell securities. The total liabilities are understood to be about £8,000,000, and were the Society to be reconstructed, and many of the securities retained, a large portion of the loss that has been incurred might be recovered. The number of shareholders at the end of March, 1910, was 19,666. In addition, there were 93,151 depositors, making a total of 112,817 accounts. Since March of last year the deposits have been reduced from nearly £11,000,000 to about £7,000,000.

CORRESPONDENCE.

IMPROVEMENTS IN THE TRANSPORT AND DISTRIBUTION OF GOODS IN LONDON.

Seeing my name mentioned in the *Journal* of the 9th inst., I venture once more to trouble you with a few observations.

I notice Mr. Gattie's friend says that he is "in entire disagreement with this statement," but I fail to understand the remark, as it seems to me the friend immediately proceeds to confirm my hypothesis. (*a*) I said, "It may be taken for granted that the bulk of orders coming by post arrive by the early morning deliveries." Mr. Gattie's friend amplifies, and states that nine-tenths of the large City and West-End houses collect the morning's mail by special messengers. Surely this implies the early morning post is very important. (*b*) Then I went on, "These orders are dealt with in the course of the day, and are ready towards evening for collection in order to be sent to various parts."

It must be obvious to those who are practically acquainted with such work that this does not mean that many orders are not ready long before the present collection time. On the contrary, it is self-evident that in order to complete each day's work a certain proportion must approach completion each hour throughout the day. The expression "towards evening" may not be clear to all, but I had in mind "any time after noon," in contradistinction to the "early morning." However, this does not help with the information which has been requested from Mr. Gattie.

Let us assume for the moment that Messrs. Maple, Shoolbred, and various others have a considerable number of orders executed and ready for collection, say, by 11 a.m. The Clearing House collects and the goods are loaded, say, on a Manchester and district train by 12.30. This train might arrive at Manchester by, say, 6.30, and at Rochdale, Oldham, &c., proportionately later. What happens to the goods? Do they remain in the Manchester "Clearing House" until the following morning? In London a train from these points reaches the Clearing House at, say, 4 or 6 a.m., and the goods are delivered as early as possible at the various large consumers' premises. What happens to the train while waiting for the load of return freight? Is not siding accommodation necessary?

If Mr. Gattie would kindly work up a specimen time-table it would be so much easier to understand his ideas. It is useless citing cases like the Tottenham-Bristol one, as, although I happen to know of another (Todmorden-Bristol), no one can seriously urge such cases of delay are general.

As I have stated, I am always in favour of anything that can be done to save time, but Mr. Gattie's references to "black magic" and to exceptional cases of delay do not help to make clear his programme.

S. CHAPMAN.

Mr. Gattie, to whom the foregoing letter has been submitted, writes as follows:—

It seems to me that Mr. Chapman's words are perfectly clear, and also that his statements are erroneous and misleading. Mr. Chapman's words are: "These orders are dealt with in the course of the day and are ready *towards evening* for collection in order to be sent to various parts." It is not "obvious" to anyone that "towards evening" means anything else but towards evening. By no stretch of language can the words be construed into an accurate statement of fact.

It must be remembered that Mr. Chapman originally endeavoured to prove that a train arriving at the Clearing House could not be unloaded and reloaded immediately, because the goods for the reloading would not be in the Clearing House at the time. It is amply clear that orders are ready for collection all day long, and not "towards evening," as stated by Mr. Chapman. A. W. Gattie.

OBITUARY.

Maung On Ghine, C.I.E., A.T.M.—The death occurred in London on the 10th inst., after an operation, of Maung On Ghine, in his fifty-fifth year. He represented the Province of Burma at the Coronation of King Edward VII., and it was in accordance with a suggestion of the Government that he came to London this year. He was well known in Rangoon, where his business life was spent in close association with the Bombay-Burma Company, and he was an active and public-spirited member of the Rangoon Municipal Council. In 1885 he received the personal title *Ahmúdan gang Tazeik-ya Min* (i.e., The Recipient of the Medal for Good Service), indicated by the letters A.T.M. after the name, and in 1879 he was created a Companion of the Most Eminent Order of the Indian Empire. He became a member of the Royal Society of Arts in 1900.

NOTES ON BOOKS.

Income-Tax. By F. B. Leeming. London: Effingham Wilson. 2*s.* 6*d.* net.

Mr. Leeming divides the tax-paying community into two classes—"those who don't pay what they ought, and those who pay more than they need"; and his work is "intended to lead the former into the right path, and to show the latter the absurdity of paying too much for want of very little trouble." There can be no doubt that a very large number of people, whose honesty otherwise is sufficient to pass muster, think it justifiable to make false returns of their income for the purposes of taxation; but it is a little surprising to learn from this book what a large number of persons err in the opposite direction—not, it is to be feared, from any altruistic desire to benefit the State, but simply because they cannot understand the somewhat complicated schedules and regulations with which the Income-Tax Commissioners supply them. It seems probable that in future the would-be evaders of the tax are likely to find their task more difficult, for the Commissioners are taking steps to secure more accurate returns, and also returns from many who have hitherto, by frequent changes of address and other devices, contrived to escape altogether. In view of this more stringent enforcement of the law, Mr. Leeming's book will become more valuable than ever to those who honestly desire to ascertain what their precise liabilities are. Undoubtedly, in many cases, these are not easy to discover, *e.g.*, what items are allowed as expenses, the precise circumstances in which the incomes of husband and wife are regarded as one, the allowances on life and accident insurance, the various conditions under which the tax may be recovered, etc. Points such as these Mr. Leeming discusses in great detail, and he illustrates them with cases with which, as an accountant, he has had to deal. His explanations are as simple as the extreme complexity of the cases permits, and the book deserves the careful study of all who have found difficulty in filling up their income-tax schedules correctly.

The Slide-Rule. By Charles N. Pickworth. Twelfth Edition. Manchester: Emmott & Co., Ltd.; London: Whittaker & Co. 2*s.* net.

The fact that this little practical manual has now reached its twelfth edition is a sure proof of its utility and excellence. The letterpress has been once more revised, and descriptions of several new slide-rules have been added. The book contains many hints, suggestions for solving formulæ, new methods of extracting cube-roots, etc., and is of great value to students in the solution of mathematical and physical problems.

GENERAL NOTES.

The Pearl Fisheries of Queensland.—Queensland has a coast line of about 3,000 miles, and products of the sea, including *bêche-de-mer*, found along the Great Barrier Reef, lobsters, oysters, turtles, etc., are of considerable importance as sources of profit. The pearl fisheries along the northern coast employ large numbers of people, chiefly Japanese and Chinese Malays. The pearls found in Torres Straits, near Thursday Island, the chief centre of the industry, are usually small, and their aggregate value inconsiderable, but the shells are marketed in large quantities. A pearl found in Queensland was recently exhibited in Melbourne. It weighed 32¼ grains, and was valued at over £1,000.

Giant Melons in Asiatic Turkey.—The American Consul at Harput says that both the water and musk-melon of Diorbekir are the largest he has ever seen. Water-melons grow in Diorbekir each as large as a flour barrel, and musk-melons but little smaller, only the musk-melon is rounder, like a pumpkin. These melons are grown in the bed of the Tigris, as after the spring rains are over, and the snows have all melted from the mountains, the river shrinks to comparative insignificance, and large tracts of the bottom land are thus exposed. This land is ploughed, and in each hill where the seeds are planted a quantity of pigeon manure is mixed in with the earth. There are people in Diorbekir engaged in breeding pigeons for no other purpose than to sell the manure to the melon growers. As the melons are growing over the moist soil of what was a river for six months of the year, no irrigation is necessary, and though it seldom rains during the summer, the melon vines never dry up. The meat of these water and musk-melons is, however, very coarse, not nearly so sweet as the melons of smaller varieties grown in other parts of the country.

Experimental Station for Rice Culture at Vercelli.—The establishment of an experimental station for rice culture at Vercelli has recently been authorised by Royal Decree. The institution will be supported by grants from the province of Vercelli, the various communes, the agricultural societies, as well as by subscriptions from the landowners and agriculturists of the district. Its object, as the name implies, will be the promotion and improvement of the cultivation of rice in this part of the country. It is anticipated that by systematic experiments, and by the gathering of first-hand information respecting the actual conditions of the cultivation of this grain in other countries, rice growers will be enabled to obtain from the institution, not only the most suitable varieties of seed for their land, but also practical advice for its cultivation and preparation for the market.

Trade of Port of Paris.—According to the latest statistics published, the total movement of the Port of Paris amounted to 10,940,525 metrical tons in 1909 (metrical ton = 19 cwt. 77 lbs.), exceeding that of the Port of Marseilles, which amounted to 7,803,793 tons during the same period. The quantity of merchandise discharged was 6,197,414 tons against 2,566,000 tons loaded. The enormous excess in the tonnage of the imports over that of the exports is characteristic of Paris, where the requirements of the population in provisions, fuel and raw material must of necessity be far greater in weight than the manufactured goods sent away. The quantity of merchandise in transit was 1,809,800 tons, whilst the local traffic amounted to 867,230 tons. The extension of the quays within the fortifications of Paris, which include the Seine, the canals of St. Denis and St. Martin, as well as the Canal de l'Ourcq, is upwards of 25 kilometres (about 15 miles).

The Chinese Cotton Industry.—In the Wei Basin, Central Shansi, is to be found some of the most fertile land in China. Here large quantities of cotton are grown. Hsing-ping is the main cotton-producing district in the Wei Basin. The cotton grown from the native seeds produces a shorter but stronger fibre than that produced from the American seed. The native gin is an ingenious affair. It consists of a corrugated iron roll about half an inch in diameter and about twenty inches long, set close to a wooden roll about three-quarters of an inch in diameter. The wooden roll is worked by a crank turned by hand. The iron roll is worked by a treadle-wheel. The wheel is about two feet in diameter, with a crank-pin about four inches from the axle. A rod connects the crank-pin with the treadle-stick, the latter being a rough tree-branch ending in three prongs. The workman stands with his right foot on the treadle-stick, by means of which he turns the iron roll, and with his left hand turns the crank which revolves the wooden roll, while with his right hand he places the cotton pods in the rolls. The rolls pull all the fibres off the seeds and carry them through, while the seeds drop without having been carried through. The cotton seed is used for oil.

German Emigration and Immigration.—While in 1908 the number of German emigrants showed a decrease of 11,813 persons over the previous year, the year 1909 witnessed a revival of emigration to the extent of 5,038 persons more than in 1908. Of the 24,921 emigrants, 18,315 departed from German ports. At the Dutch ports of Rotterdam and Amsterdam 4,536 German emigrants embarked, whereas in 1908 only 1,300 emigrants left those two ports. In previous years the province of Posen contributed the largest number of emigrants, but in 1909 Brandenburg (including Berlin) was responsible for the majority. In proportion to population the city of Bremen again shows the largest number of emigrants. As in former years, the United States was the chief goal of attraction, 19,930 emigrants out of the total of 24,921 journeying thither. British North America claimed 367, Brazil a like number, and other sections of the American continent 3,889. Australia received 178, Africa 26, and Great Britain 164 German emigrants. In spite of the emigration increase, the percentage of agricultural emigrants decreased in 1909. In 1907 nearly 2,000 emigrants of this class left Germany, as against 1,070 who departed in 1909. Male emigration is more pronounced than female, the ratio being three to two. The number of so-called immigrants arriving in Germany during 1909 was 127,618, but this figure includes those persons rejected and deported by the United States immigration authorities. The exact number of those returning from the United States, either voluntarily or compulsorily, was 80,900; from the West Indies and Mexico, 981; from South American States, 8,499; from East Africa, 1,374; and from Australia, 616.

Journal of the Royal Society of Arts.

No. 3,057. VOL. LIX.

FRIDAY, JUNE 23, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

FINANCIAL STATEMENT FOR 1910-11.

The following statement is published in this week's *Journal* in accordance with Sec. 40 of the Society's By-laws :—

TREASURERS' STATEMENT OF RECEIPTS AND PAYMENTS FOR THE YEAR ENDING MAY 31st, 1911.

Dr.

	£ s. d.	£ s. d.
To Cash in hands of Messrs. Coutts & Co., May 31st, 1910		2,562 12 11
,, Subscriptions	5,287 14 0	
,, Life compositions	289 16 0	
		5,577 10 0
,, Dividends and Interest		668 13 10
,, Ground Rents		647 10 3
,, Examination Fees		4,332 19 2
,, Advertisements		450 7 6
,, Sales, etc.:—		
Cantor Lectures	11 17 2	
Examination Programmes	46 12 1	
Fees for use of meeting-rooms	61 8 6	
Journal	147 5 2	
Leather Committee Reports	0 7 10	
Society's Directory	0 4 6	
		267 15 3
,, Donation to Examination Prize Fund :— Clothworkers' Company		30 0 0
,, Investments :— Canada 4 per Cent. Stock redeemed		423 0 0
		£14,960 8 11

Cr.

	£ s. d.	£ s. d.
By House :—		
Rent, Rates, and Taxes	806 10 10	
Insurance, Gas, Coal, House expenses, and charges incidental to meetings	319 4 1	
Repairs and Alterations	96 19 9	
		1,222 14 8
,, Office :—		
Salaries and wages	2,510 2 0	
Stationery, Office Printing and Lithography	458 17 8	
Advertising	81 5 6	
Postage Stamps, Messengers' Fares, and Parcels	288 14 7	
		3,338 19 9
,, Library, Bookbinding, etc.		79 10 1
,, Conversazione (1911)		20 17 8
,, **Journal*, including Printing and Publishing		1,972 14 9
,, *Advertisements (Agents and Printing)		274 7 0
,, Examinations		3,931 4 8
,, Medals :—		
Albert	19 17 6	
Society's	17 12 8	
		37 10 2
,, Owen Jones Prizes		5 1 4
,, Royal Drawing Society Prizes		11 3 10
,, Juvenile Lectures		20 0 0
,, Cantor Lectures		214 7 2
,, Sections :—		
Colonial	46 17 5	
Indian	67 19 0	
		114 16 5
,, Committees (General Expenses)		20 12 9
		11,264 0 3
,, Cash in hands of Messrs. Coutts & Co., May 31st, 1911 (including £423 Canada 4 per Cent. Stock redeemed, to be reinvested)		3,696 8 8
		£14,960 8 11

* Payments for eleven months only.

Liabilities.

	£	s.	d.	£	s.	d.
To Sundry Creditors	1,047	2	3			
,, Examiners' Fees	1,383	8	6			
,, Examination Prizes and Medals	210	0	0			
,, Sections:—Colonial and Indian	110	0	0			
,, Accumulations under Trusts	407	3	8			
,, Canada 4 per Cent. Stock redeemed, to be reinvested	423	0	0			
				3,580	14	5
,, Excess of assets over liabilities				25,218	16	1
				£28,799	10	6

Assets.

	Amount of Stock, etc. £	s.	d.	Worth on May 31st, 1911. £	s.	d.	£	s.	d.
By Society's Accumulated Funds invested as follows:									
Newcastle-on-Tyne 3½ per Cent. Stock	3,000	0	0	2,940	0	0			
Canada 3½ per Cent. Stock	500	0	0	510	0	0			
South Australia 4 per Cent. Stock	500	0	0	505	0	0			
N.S. Wales 3½ per Cent. Stock	530	10	1	522	11	0			
N.S. Wales 4 per Cent. Stock	500	0	0	530	0	0			
G. Indian Pen. Ry. 4 per Cent. Debenture Stock	217	0	0	235	9	0			
Queensland 4 per Cent. Bonds	1,500	0	0	1,530	0	0			
Natal 4 per Cent. Stock	500	0	0	535	0	0			
Ground-rents (amount invested)	10,496	2	9	10,496	2	9			
Metropolitan Water Board B. Stock	321	15	9	275	2	0			
New River Co. shares	6	0	0	6	0	0			
India 3½ per Cent. Stock	3,408	14	6	3,263	17	1			
	21,480	3	1				21,349	1	10
,, Subscriptions of the year uncollected				756	0	0			
,, Arrears, estimated as recoverable				292	0	0			
							1,048	0	0
,, Property of the Society (Books, Pictures, etc.)							2,000	0	0
,, Advertisements due							306	0	0
,, Cash in hands of Messrs. Coutts & Co., May 31st, 1911 (including £423 Canada 4 per Cent. Stock redeemed, to be reinvested)							3,696	8	8
,, Do. on Deposit (against interest on Trusts)							400	0	0
							£28,799	10	6

Funds held in Trust by the Society.

	£	s.	d.	
Dr. Swiney's Bequest	£4,477	10	0	Ground-rents, chargeable with a sum of £200 once in five years.
John Stock Trust	100	0	0	Consols, chargeable with the Award of a Medal.
Benjamin Shaw Trust for Industrial Hygiene	133	6	8	,, ,, ,, of Interest as a Money Prize.
North London Exhibition Trust	192	2	1	,, ,, ,, ,,
Fothergill Trust	388	1	4	,, ,, ,, of a Medal.
J. Murray and others, in aid of a Building Fund	75	14	4	,, £54 18s. 0d. and India 3½ per Cent. Stock £20 16s. 4d.
Subscriptions to an Endowment Fund	562	2	2	,,
Dr. Aldred's Bequests	220	2	3	,, chargeable with the Award of a Prize.
Thomas Howard's Bequest	571	0	0	Metropolitan Railway 3½ per Cent. Preference Stock, chargeable with the Award of a Prize.
Dr. Cantor's Bequest	648	19	7	Bombay and Baroda Railway Guaranteed 3 per Cent. Stock — Interest applied to the Cantor Lectures.
	3,273	16	6	India 3 per Cent. Stock — Interest applied to the Cantor Lectures.
	2,695	11	3	Ground-rents — Interest applied to the Cantor Lectures.
Owen Jones Memorial Trust	423	0	0	Cash in the hands of Messrs. Coutts & Co. to be reinvested, chargeable with the Award of Prizes to Art Students.
Mulready Trust	105	16	0	South Australia 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
Alfred Davis's Bequest	1,953	0	0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock. Interest at the disposal of the Council for promoting the objects of the Society.
Francis Cobb Fund	255	14	1	New South Wales 3½ per Cent. Stock.
Amount to cover accumulated Interest on Trust Funds	400	0	0	On deposit with Messrs. Coutts & Co.
	£16,475	16	3	

TOTAL OF INVESTMENTS, ETC. (FACE VALUE), STANDING IN THE NAME OF THE SOCIETY (INCLUDING SOCIETY'S ACCUMULATED FUNDS AND TRUSTS AS ABOVE).

	£	s.	d.
Ground-rents (amount of cash invested)	£17,669	4	0
Consols	1,650	12	6
Metropolitan Railway 3½ per Cent. Preference Stock	571	0	0
Bombay and Baroda Railway Guaranteed 3 per Cent. Stock	648	19	7
India 3 per Cent. Stock	3,273	16	6
India 3½ per Cent. Stock	3,429	10	10
Canada 3½ per Cent. Stock	500	0	0
South Australia 4 per Cent. Stock	605	16	0
New South Wales 3½ per Cent. Stock	786	4	2
New South Wales 4 per Cent. Stock	500	0	0
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170	0	0
Queensland 4 per Cent. Bonds	1,500	0	0
Natal 4 per Cent. Stock	500	0	0
Newcastle-on-Tyne 3½ per Cent. Stock	3,000	0	0
Metropolitan Water Board B. Stock	321	15	9
New River Company Shares	6	0	0
Cash on Deposit with Messrs. Coutts & Co.	400	0	0
Cash in the hands of Messrs. Coutts & Co. awaiting reinvestment	423	0	0

Society's Accumulated Funds	21,480 3 1	£37,955 19 4
Trust Funds held by Society	16,475 16 3	

The Assets, represented by Stock at the Bank of England, and Securities, Cash on Deposit, and Cash balance in hands of Messrs. Coutts & Co., as above set forth, have been duly verified.

CARMICHAEL THOMAS, JOHN M. THOMSON, } *Treasurers.*

H. T. WOOD, *Secretary.*

KNOX, CROPPER & Co., *Auditors.*

Society's House, Adelphi, 20th June, 1911.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Fifty-Seventh Annual General Meeting, for the purpose of receiving the Council's report and the Treasurers' Statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the By-laws, on Wednesday, June 28th, at 4 p.m.

(By order of the Council),

HENRY TRUEMAN WOOD, *Secretary.*

EXAMINATIONS.

The results of the Advanced Examinations (Stage III.) will be published at the end of the present month.

The results of the Intermediate Examinations (Stage II.) will be published during July, and those of the Elementary (Stage I.) in August.

SCIENCE AND INDUSTRIAL APPOINTMENTS.

To what extent is there a demand for men of scientific training in the industrial and commercial world? This question has been forced upon the attention of the writer by the extraordinarily conflicting accounts which reach him from different sources. On one side he is told that the demand is at least as great as the supply—that practically every well-trained man of science, unless he is handicapped by some personal blemish of mind or body, may make sure of earning a reasonable living in some branch of industry. On the other hand, he hears bitter complaints from Oxford men of high academic qualifications—some even of

Fellowship standing—that, do what they will, they are driven to teach. One such person—who was formerly a tutor at one of the best Oxford colleges, and who, being unwilling to teach, has found himself compelled to abandon science for another profession—writes that half the men who took first classes in science in his year are earning £120 per annum teaching chemistry, and the rest have drifted out of science altogether.

Complaints of this nature are necessarily made in private; no attempt has been made—probably none could be made—to ascertain the number of men of sound scientific training who, though anxious to enter some branch of industry, have been forced to teach for a living. There can be little doubt, however, that they are fairly numerous. And this state of things, by the way, means a fourfold disaster. It is disastrous for the men who are driven into a profession they dislike; it is disastrous for their little victims, who cannot be expected to catch much enthusiasm for science when their teachers are suffering from boredom; it is disastrous for the profession which becomes overcrowded with underpaid and discontented drudges; and it is disastrous for the industries which might reasonably be expected to profit were the energies of these unfortunate men directed into more congenial channels.

From the very nature of the case, therefore, it is difficult to obtain any evidence in black and white showing the nature and extent of the trouble complained of; but something of this sort is furnished in an Appendix to a Report on the Revision of Regulations for the Award of Senior County Scholarships, issued in 1910 by the Education Committee of the London County Council. One scholar "obtained Ph.D. (Leipsic) and is now holding a Salters' Company's research fellowship. Hopes to obtain post in industrial world, but regrets that there seems very little demand for men with his training." A second, "after graduating Ph.D., has vainly endeavoured to obtain post as chemist in an industry for which he feels a natural inclination, his only chance being an offer of £80 per annum. He regrets being practically compelled to take up teaching." A third, "although a fully-qualified electrical and mechanical engineer, states that he has been unable to find permanent daily commercial employment, even at a bare living wage." A fourth "states that the market is flooded with highly-trained teachers of chemistry and physics who are thus compelled to accept small salaries . . . He regrets that at present the men sent to Oxford and Cambridge are mostly driven to become teachers." A fifth "is an Associate of the Royal School of Mines and B.Sc. (Engineering). Since 1908 has been unable to secure employment."

But, although there is a decided current of complaint in this document, its evidence as a whole is by no means unanimous. Out of ninety-three men scholars, six have obtained appointment as engineers, and nine as chemists in works, whilst one "states that Council scholars are doing useful work in the great industries."

Mr. Robert Blair, Education Officer of the London County Council, was at great pains to collect evidence on the point under discussion, and he summarised it in an extremely interesting address entitled "The Relation of Science to Industry and Commerce," which he delivered before the British Association at Sheffield last year. He sent some five hundred letters of inquiry to teachers of repute at home, in France, Germany and America; to representative firms of employers, and to thirty of His Majesty's Consuls in Europe, Asia, and the two Americas. He is of opinion that, upon the whole, the evidence placed at his disposal shows a tone of great hopefulness. With regard to agriculture, it would appear that those who have been trained in agricultural colleges have generally found posts in this or in allied industries. "The evidence from the engineering colleges and institutions," writes Mr. Blair, "is also, on the whole, satisfactory. Here and there may be found somewhat doleful notes to the effect that the large majority of State and local authorities do not lay themselves out to take advantage of technically-trained men, and, in one case, a view that has much popular currency has been put to me in fairly strong terms. It is to the effect that employers, especially those who have not very large and important undertakings, but who, nevertheless, would have their businesses improved by securing technically-trained men, have an ignorant prejudice against such assistance. It is suggested, as the possible explanation of their attitude, that the employers fear that, if they engaged men of greater attainments than themselves, they would simply be raising up possible opponents in their own line of business. There may be much truth in this view, which does not, of course, apply to first-class firms. But there is, I think, another view worth full consideration—that the size of the business concern (the amount of capital sunk in it) has much to do with the employer's attitude. The employer does not possess the faith that will

enable him to risk the addition of another salary to his working expenses; and no one, without a fair trial, is able to give him the mathematical demonstration which he seeks that the salary might often be saved merely out of the waste of materials which exists owing to the absence of scientific knowledge on the part of his men of the materials they are handling, and to their having to feel their way by experiments that are more in the nature of guesses. Such firms will be converted only by the example of others."

Upon the whole, then, it would seem that in the case of agriculture and engineering we are now fairly alive to the necessity of the man of science. How is it with industrial chemistry? It is, unfortunately, difficult to procure any but the sketchiest of statistics. In most cases of this sort appointments have been made through the personal recommendation of professors, and, as a rule, the universities and colleges have not kept records of their students' after careers. Even when such records do exist, the authorities seem very reluctant to make them public. Of course, a great deal of the work done by the appointments boards is of a highly confidential nature, but it is hard to understand why some information cannot be given in general terms—terms so general that they would not lead to the identification of the persons in question—as to the number and nature of the posts obtained.

Mr. Blair, who has also suffered from the difficulty of obtaining precise statistical details, is of opinion that a change for the better is coming over the country in this respect. He writes: "One of the largest technical institutions says: 'We are fairly sure of placing at once all the best men who have taken a graduating course in any branch of applied chemistry.' Another technical institution—probably the largest—states: 'We have been unable, during the last three or four years, to meet all the demands upon us for trained chemists, and at this moment we are unable to make nomination to two or three most important posts for which chemists are required, because all our men are satisfactorily placed.' From one of our oldest universities comes the statement: 'There is no difficulty in placing chemists of the highest rank in first-rate technical posts. By highest rank, I mean people with approximately Fellowship standing and great originality.' Sir William Ramsay writes: 'Some months ago I had the curiosity to pick out from my class lists, back to about 1890, a hundred names of men (and women) whose subsequent history I know. The result was, roughly: Sixty in industry (analysts, private or in works, managers, proprietors of works, etc.); twenty-five in teaching posts (assistants in universities or university colleges, schoolmasters, and a few professors—about six); and fifteen given up (married women, men who have changed their profession or dead).'"

It seems to be beyond a doubt, then, that in certain industries, at least, there is already a fair demand for men of first-rate scientific training. It is also quite as certain that the complaints heard in many quarters concerning the difficulty sometimes experienced by such men in securing industrial appointments have some basis in fact. This seems to point to a serious lack of organisation in the market, and careful investigations confirm this conjecture. What, then, are the present conditions? If a manufacturer wants to find a chemist to conduct researches in his works, does he know where, as a matter of course, he ought to go for his man? It would appear that it is very much a matter of chance whether he has such knowledge or not; still more a matter of chance whether the chemist knows where to go for an industrial appointment. In very many cases, as has been already said, such posts are obtained on the personal recommendations of professors. The manufacturer may know a professor of chemistry, the brewer may know a professor of brewing, and in either of these cases a satisfactory appointment may result; but if, as is still too frequently the case, the manufacturer has no acquaintance with the world of science, the chances are that he will either find an inferior chemist who will teach him a hearty contempt for science, or, rather than be troubled with elaborate inquiries, he will decide to continue working on the lines of his fathers before him.

And this is a state of things that ought to be altered as soon as possible. Not only ought no difficulties to be placed in the way of the business man who wishes to employ a man of science; every effort ought to be made to encourage him.

If the universities are to interest themselves in this matter—and, after all, it is they who are mainly concerned, for comparatively few men of first-class scientific attainments are trained elsewhere, and in the future there will probably be fewer and fewer—it would seem that the natural agency for promoting co-operation between science and industry should be the Appointments Boards. The Oxford Committee for Appointments has been run in an admirable but,

unfortunately, a very limited way. The appointments made through it have been almost entirely of a scholastic nature, and very little attempt appears to have been made to widen its scope. During the past three or four years some efforts have been made to induce business firms to take Oxford graduates, but so far with practically no success—a state of things which may, perhaps, be taken to account for the apparently general failure of the Oxford science man to find a footing in the industrial world. It is, too, a doubtful point whether the industrial world is aware even of the existence of an Oxford science school. That the Cambridge scientific man, on the other hand, is well known and appreciated there will be shown, it is hoped, later on.

The problem in London, owing to the size and sporadic nature of its university, is peculiar. Three or four of its constituent colleges would, in point of numbers and equipment, make respectable universities in themselves, and they have hardly as yet learnt to work together as a whole. Some two or three years ago the Senate did establish an Appointments Board, but, owing to initial difficulties, it has not yet been able to accomplish anything in the way of securing industrial posts. This, however, does not by any means imply that London has been doing nothing in that direction. For instance, the Central Technical College (now forming part of the Imperial College of Science and Technology) has won such a reputation as a school of engineering that practically all its students are sure of finding employment as soon as they leave. University College, some years ago, started an Appointments Board of its own. Unfortunately, for various reasons, it has not yet proved a great success; but some of the individual professors—notably, Sir William Ramsay, as has been already seen—have provided many scientific recruits to industry. At King's College, too, a number of men have secured such posts through their professors.

Most of the younger universities have followed the example of Oxford in instituting Appointments Boards, but inquiries addressed to these have only elicited very disappointing replies. This is possibly due to the fact that whereas the boards are beginning to be generally known as agencies for scholastic work, only few people have as yet learnt to apply to them for persons to fill industrial posts. Thus at Manchester the appointments registered are nearly all scholastic; industrial posts are generally obtained on the personal recommendation of professors, and it is impossible even to guess at their number and nature. The Clerk to the Senate at Leeds writes: "It is difficult to give any exact figures as to the numbers who have obtained appointments under the present arrangements, but the appointments themselves include engineering, dyeing, textile, and industrial posts." The Secretary of the Appointments Committee at Liverpool writes: "It is not possible to give exact figures as to the number of posts we have already filled in commercial and manufacturing firms. A considerable number of our men are employed in local chemical and engineering firms. I should say the number of such appointments in the neighbourhood of Liverpool is about fifty. Our work is not yet as widely known as it should be, a few firms only applying to us from time to time as vacancies arise."

The Registrar of Birmingham University writes: "The professors are in touch with leading manufacturers and mine-owners, and up to the present time have had no difficulty in placing the students when they have obtained their degrees, and are ready to commence practical work. In a considerable number of cases students in pure science, such as chemists, are also taken on by manufacturers, but I am afraid I have no record of these appointments, and cannot give an estimate of the number per annum."

There is nothing very definite in these replies; the letters from the other universities—English, Scotch and Irish—are even vaguer. But if they show nothing else, at least this fact emerges, that the Appointments Boards have not yet come to be recognised as the normal means for securing the co-operation of science and industry. To this rule there is one notable exception. The Cambridge Appointments Board has not yet been mentioned, because it stands apart from the rest. Founded in 1902, it has been conducted with much wisdom and success. By careful selection, in the first instances, it rapidly won the confidence of several of the most important business firms, who now return to it as a matter of course whenever they have any vacancies. Their example has naturally been followed by other firms, and the books of the board now contain many of the best-known names in the commercial world. Appointments—and valuable appointments, too—have been secured in numerous industries: in engineering, as chemists in works, in brewing, dyeing, alkali, shellac, soap, lead, glass, varnish, and many other industries;

in fact, the secretary reports that he has practically no difficulty in placing any man whom he can confidently recommend. A more recent and exceedingly interesting development is the securing of purely commercial posts by Cambridge graduates. During the last year some fifty men were settled in important administrative positions in business through the instrumentality of the Cambridge Appointments Board. This result has not been obtained, of course, without wise planning and energetic action. By its constitution, the board contains a number of eminent business men, whose advice is invaluable; while the secretary himself is in close personal touch with commercial and industrial firms in London and other parts of the country. The example of the Cambridge board and its businesslike methods ought certainly to be followed by the other universities.

Another body which is doing excellent work in this respect is the Institute of Chemistry. A register was recently started by the council on which anyone who has passed the examinations of the Institute may enter his name. This register has proved extremely successful. It has not been found possible to obtain figures as to the number of appointments made through its agency, but the registrar states that he has no difficulty in finding employment for all candidates whom he is able to recommend; indeed, the demand is now greater than the supply. He attributes this success largely to the fact that the Institute examinations are known to be of an exceedingly practical nature; and business men, when they secure the services of an Associate or Fellow of the Institute, feel confident that their employee has had something more than a mere academic training. The council are very much alive to the necessity of encouraging the union of industry and science. Many of the Fellows are, of course, men of great prominence in the industrial world, and they know—none better—the requirements both of science and industry. With a view to making these requirements more thoroughly understood, the council are proposing to institute a series of lectures to be delivered by chemists practically engaged in various branches of industry, who will describe the precise nature of their work in its actual conditions, and show how these differ from the conditions of pure science. It is also proposed to ask Fellows having expert knowledge to give students an insight into the actual work of the chemist. Such experience should prove of the utmost benefit to young chemists, for it is always found that the greatest difficulty lies in taking the first step from pure to applied science. Many business men who will fight shy of a graduate, however brilliant his qualifications, if he has only his academic qualifications to recommend him, will be glad to engage him if he can show even a short record of work under industrial conditions.

So much, then, for the avenues by which young men of science may hope to pass to industrial appointments. Let us now consider for a moment the steps which some of our leading firms are taking to secure the co-operation of science. Of course, in many kinds of works the chemist has long had a recognised position on the staff, but it is only of recent years—and it is among the most encouraging signs for the future of British industry—that any of our great business houses have expended money on purely scientific research on the chance that discoveries might be made which might prove of value to the industries with which they were concerned. Let two examples suffice.

For the last ten years Messrs. Arthur Guinness, Son & Co., Ltd., have maintained a research laboratory of their own, under the direction of Dr. Horace T. Brown, F.R.S., who is assisted by a chemist, a botanist, and two "administrators." The laboratory was founded with "the object of carrying out a systematic series of investigations on the varying nature of barley, and the complex changes which it undergoes during the early stages of the germinative process." These investigations offered a large number of extremely difficult and complicated problems—chemical, biological, and agricultural—which, at the time of the establishment of the laboratory, had hardly been so much as formulated. But of their importance alike to pure science and to the brewing industry there could be no doubt. Thus, as Dr. Brown wrote in 1903, "could we determine, in the early stages of the germination of a grain of barley, all the 'down-grade' chemical changes of the nitrogenous substances stored in the endosperm, and follow the products as they enter the embryonic plant and are once more built up into proteid, we should have a key to many obscure problems connected with the life processes of plants and animals; hence any investigation like the present must have a scientific interest and application reaching far beyond the scope of a mere technical inquiry." A large amount of research work has been carried out in the laboratory, and the results have been published from time to time. That the firm have not suffered financially

from their belief in pure science, their dividends seem conclusively to prove.

The well-known firm of Messrs. Burroughs, Wellcome & Co. have also been great pioneers in this respect. In 1896 Mr. Henry S. Wellcome founded the chemical research laboratories in King Street, E.C., which bear his name, and which have since been conducted under the direction of Dr. Frederick B. Power. The investigations conducted here have been of a very varied character and wide range They have comprised, amongst other subjects, the complete chemical examination of a large number of plants or plant products, which, on account of their reputed medicinal value or other properties, have been considered of special interest. Over a hundred papers, giving the results of these investigations, have been published in various scientific periodicals, and these have been freely distributed to those interested in the subjects of which they treat, and to such institutions and libraries as desire to preserve a record of them.

Mr. Wellcome also founded the physiological research laboratories at Herne Hill, where investigations are carried on under Dr. H. H. Dale in connection with physiological phenomena generally, and more particularly with the study of sera and anti-toxins. Much very useful work has also been achieved in the standardisation of drugs—a most important point, considering the extraordinary potency of many of the drugs in common use to-day. Both these institutions are independent of the business organisation of the firm, and are under separate direction.

Quite apart, however, from the chemical and physiological research laboratories, Messrs. Burroughs, Wellcome & Co. carry out a large amount of scientific investigation at their own works. Chemical, pharmacological, and botanical research is now conducted under most suitable conditions in the laboratories of the Wellcome Chemical Works at Dartford, where a number of highly-trained scientific workers are employed, and where very valuable inquiries into the nature and standardisation of drugs, sera, anti-toxins, etc., have been conducted.

But while, in the work of such firms as have been named, one rejoices to see signs that British industry is awaking to the necessity of calling in the aid of pure science, one must not be cajoled into the hope that we have as yet touched more than the fringe of the problem. Mr. Blair—if one may quote him once again—states his opinion thus: "I see no reason for believing that the number of highly-trained chemists who find their way from colleges into industrial chemistry is anything else than insignificant compared with similar figures for Germany or the United States of America." Our awakening has been at best but partial; certain trades appear to be still very sound asleep. It is, perhaps, invidious to name any branch as being more somnolent than the others, but it may be noted as a significant fact that recently, when an admirable course of lectures on brick-making was delivered before this Society, very few of the many round London who are supposed to be interested in the trade took the trouble to attend, although a certain Continental firm thought it worth their while to send a representative from Germany. And it is to be feared that this attitude is only too characteristic of the two nations generally. German manufacturers are eager for scientific knowledge, and will take any amount of trouble to secure it. In many cases the British manufacturer turns up his nose when it is offered to him. The results of this difference of attitude may be seen in a hundred directions, in none, perhaps, more strikingly than in the case of the aniline dye trade and in the steel trade which, once practically British monopolies, have now, thanks to the up-to-date and scientific development of German plant, become, to a large extent, German industries. Nor are the Americans less alert than our Continental rivals. A short time ago a society was founded in London for the study of paint and varnish. As soon as its establishment was announced numerous inquiries for its papers were received from the United States; none from people in this country.

Indeed, we have as yet but little ground for complacent self-satisfaction. Vast fields of industrial enterprise still lie untouched by our men of science—fields, too, in which other countries already provide us with striking object-lessons. Take the meat industry, for instance, The question of utilising the residual products in this branch is comparatively untouched in the United Kingdom. Here the number of by-products derived from a bullock is about ten, while in the large packing-houses of Chicago and the River Plate it runs to something like a hundred. Every part of the animal is used for some purpose or other, and there is absolutely no waste; and it is for this reason that foreign meats, equal in quality to our own produce, can be sold for a penny and twopence a pound less than the British article in the United Kingdom, notwithstanding all the intermediate charges which have to be made for transport, refrigeration, handling, etc. If some means were taken to

collect the large quantities of meat-trade residues which are available in this country, there is no doubt that they could be put to very profitable use, and at the same time prevent the huge waste which at present takes place. The case is very much the same with the fish industry. True, at certain centres, notably Montrose, Fraserburgh, Grimsby, Fleetwood, and Milford Haven, there are factories specially designed for dealing with the residual products, but in the other great fishing centres the raw material of these products (fish-oil, fish-meal, and fish-guano, for all of which there is a demand greatly in excess of the supply) is simply barged out to sea and wasted.

These are but two examples taken at random. It would be easy to multiply instances almost indefinitely, but perhaps enough has been said to indicate how vast is the scope of the problem before the man of science in the industrial world. Practically every department of trade is crying out for him, and offering, too, substantial rewards for his services. Who can say what branch does not hold a chance of repeating the success of Sir William Perkin, who created a great new industry by finding a use for a hitherto worthless material?

Let us hope, however, that it is no longer necessary to labour the point of the importance of science to industry. That was not so much the object of this article as to show that there are numbers of first-class men of science eager but unable to enter the industrial field (in which there really exists plenty of scope for them); and, secondly, to see if there are any means by which the men and the posts can be brought together. It appears to the writer that the Cambridge University Appointments Board has gone far to solve the problem. Let the other universities follow this example, modelling their work on the broad and liberal lines which Cambridge has adopted, and placing themselves in touch, as she has done, with the industrial world. There are now seventeen universities in the United Kingdom. If there were as many boards in full swing throughout the country, they would soon become known among manufacturers and men of business, and recognised as the legitimate channels of communication between science and industry.

G. K. Menzies.

BEDOUIN DESERT BREAD.

The "samh" is a small plant which grows wild, the Bedouins say, all over the desert plateau east of Maan on the Mecca railway, where nothing is cultivated, there being insufficient rain for any grain to grow. The plants grow close together, with short stems like lentils. The Bedouins pull them up by hand, and beat them with a stick, which has the effect of removing the small seed-pods. These are then taken to the wells, and holes are made in the sandy clay soil and filled with water. The seed-pods are thrown into these holes in small quantities, and stirred by the women, with sticks and their bare feet. The action of the water opens the pods, the seeds fall to the bottom, while the hulls float. Only about ten minutes in the water are required to open and separate them. The hulls are then skimmed off and the operation repeated. When sufficient pods have thus been treated, the water is dipped out and the seeds spread out to dry. The seeds are then sifted through fine sieves, to take out as much of the grit as possible, and ground in basalt handmills into flour, and the bread is either baked on a "saj"—a convex sheet iron of circular form, placed on small stones and heated, from underneath generally, with a manure fire—or in a "taboon," a dome-shaped clay oven, with an opening at the top, which is kept hot by a smouldering fire on the outside, always kept burning, and the floor is covered with pebbles on which the loaves are laid and baked. The bread is very black and gritty, the latter being accounted for by the way the seeds are hulled in the sandy holes. To improve the bread the natives add a little sugar to the flour, or a kind of molasses made from the seeds of the juniper tree (*Juniperus phornicea*) by boiling and then straining them. The juniper grows wild abundantly around Petra and the neighbouring mountains. The plant grows in a clayey, sandy, saline soil, and where very little rain falls; it ripens about the same time as barley, but, unlike most other plants, the seed-pods do not open when ripe. They are affected by dampness but not by heat, which enables the Bedouin to collect them throughout the summer.

THE DISTILLATION OF ORANGE FLOWERS AT GRASSE.

The distillation of orange flowers on the French Riviera, and particularly in the district surrounding Grasse, is a very important industry. Here 3,000 tons of these flowers are produced annually, not including the leaves and even the young fruit of the orange, which is also utilised for making the essential oil, so valuable in the manufacture of perfumes. The best quality of oil, called *néroli*, is obtained from the flowers of the wild, or bitter orange tree, locally termed *bigaradier*. The flowers of the sweet orange are not so productive, and yield a quality known as *néroli doux*, which is inferior to the other. A still more inferior quality is obtained from the *brouts* (the leaves and newly-formed fruit), this quality is called *petit grain*.

The flowers are gathered during the month of May. For their distillation an ordinary still may be used, but a special apparatus is preferable.

These are of smaller size at bottom than those employed for distilling spirits, and somewhat higher; a grating is also provided, so that the flowers and leaves are not in direct contact with the fire. An ordinary-sized still should contain about 40 kilogrammes of flowers (88 lbs.), and between 50 and 60 litres (11 and 13 gallons) of water. This should yield from 30 to 40 litres (6 to 8 gallons) of liquid.

The products of distillation pass from the still into a receiver, so arranged that the condensed liquid always remains at the same level in it, the water is drawn off from the bottom by a bent tube, whilst the globules of essential oil that float on the surface are collected at the top of the vessel. The oil, though not very soluble in water, is sufficient to impart its perfume to it, and is sold as *eau de fleur d'oranger*, whilst that obtained from the distillation of the leaves is termed *eau de broute*. A kilogramme of orange flowers yields, on the average, 2 grammes (30·86 grains) of *néroli*, worth from 500 to 1,000 francs per kilo (£9 1*s*. 7*d*. to £18 3*s*. 2*d*. per lb.). The orange-flower water is sold, on the average, at 25 centimes per litre (about 2½*d*. per quart). The leaves yield about 1½ grammes per kilo of *petit grain*, worth about one-tenth the price of the *néroli*. The quantity of flowers furnished by each tree varies considerably, and depends on age, vigour of growth, situation, soil and other circumstances. A well-kept garden near Grasse, with trees, half of which were forty years and the other half twenty-two years old, has produced as much as 2,800 kilogrammes (about 2 tons 15 cwt.) in a single year. The cost of planting a hectare of orange trees is estimated at 4,000 francs, or about £65 per acre.

HOME INDUSTRIES.

Lead Poisoning.—The reports on lead poisoning in the Potteries, to be found in the Annual Report of the Chief Inspector of Factories and Workshops just issued, are, on the whole, encouraging. Having regard to the comparative briskness of trade, the number of cases of lead poisoning in the year under review shows some little improvement. Mr. Shuter draws attention to the practical immunity of the jet and rocking branch from lead poisoning, which is remarkable when it is remembered that the glaze used at these works contains, as a rule, a larger percentage of lead than is the case in the general earthenware and china branches. In each case of lead poisoning a sample of glaze was collected and submitted for analysis, and it was found that the highest percentage of lead was 33·1, while the lowest was 11·2. It seems certain that on the whole greater care is being exercised by employers and employed, with a view to a more careful observance of the special rules so far as they affect this question. In some cases improvements are being effected in the lavatory accommodation, while in others new mess-rooms are being erected. Then some of the employers are anticipating the proposed new regulations, and are putting down impervious floors with facilities for flushing and draining; others, again, are having the walls of their dipping houses tiled, with the result that the places are lighter, cleaner, and much more free from dust. There is also a serious attempt on the part of some of the occupiers to use low solubility glazes. Some are using glazes that contain less than two per cent. soluble lead, while in one or two cases a leadless glaze is used to a great extent. Several of the firms have supplied their lead workers with pills known as anti-lead pills, and the men speak highly of their effect. Mr. Shuter says that the inspectors are satisfied that the best lines upon which to work with a view to fighting the evils of lead poisoning are: (1) efficient exhaust ventilation for the dust; (2) reasonable temperatures in which to work; and (3) scrupulous cleanliness on the part of the workers.

Women Workers and Childbirth.—Not much progress seems to be made in checking the industrial employment of women immediately before and after childbirth. As in former years, the majority of cases brought before the inspectors prove to be those which are untouched by the present law; in which means of support fail for the expectant or actual mother, and work and privation drive them hard at the time when, most of all, help is needed. A sad illustration is given by Miss Martindale, of a woman returning to work within a month after childbirth. The woman had five children under six years of age, three of whom could not walk. The woman's husband was a painter by trade, but had been out of work for seven months, and the woman was practically obliged to work up to the night of her confinement, and, although she was aware of the law, returned to work at the end of two weeks, in spite of being weak and unfit for work, rather than see her children starve. Miss Vines reports that the majority of the cases noted of mothers who have returned to work in the mills within a month of childbirth has again been found to be in Dundee. This place, with a population of 168,000 persons, is a town whose chief industry is carried on for the greater part by women, girls, and boys. The census figures of 1901 gave the total number of workers employed in the jute industry as over 37,000, and of those only 16 per cent. were males over twenty. In a recent month, of the eight cases investigated by a social settlement worker in Dundee, of mothers who had resumed work at the jute mills within a month of confinement, five out of the eight babies were found to be dead, two were alive, and one could not be traced. Of the eight, four were legitimate, four were illegitimate, and three out of the five deaths had been those of illegitimate children. The mother, eighteen years of age, of one of the living infants, was married about six weeks before the baby was born. After its birth her husband, aged twenty, deserted her, and threw up his job at the mill, saying it was too heavy. Possibly the number of deserted

wives and illegitimate births in Dundee, and the return of married women to the factory within a month of confinement, is connected with the fact that a married woman living with her husband is disqualified for the receipt of Poor Law relief, whereas the unmarried or deserted mother may, if destitute, be granted adequate medical attendance and maintenance, whatever her conduct or character, and can actually claim it as a legal right. The law would seem to put a premium on wife desertion.

Humidity.—Recently attention was directed in these Notes to the complaints of mill hands with regard to humidity in mills, and in the Factories Report the matter is referred to by Miss Squire and others. In her report, Miss Squire says that in Preston, in visits to thirty-four mills, the full limit of humidity allowed by law was found in seven cases, and excess in two. In Darwen, in visits to fifty mills, the full limit of humidity was found in seventeen cases, excess in three; on revisiting these mills, full limit was again found in eight and excess in one. Miss Lovibond was struck by the fact that whenever complaints were received from the weavers of discomfort or injury to health from the steam, there the shed is found to be one in which steaming to the full limit is the practice. The difficulty of obtaining a reading of the hygrometer before the conditions have been altered by the turning off of steam is great. The appearance of the inspector at the lodge is often the signal for the tackler to run and turn the steam off. By the time the inspector reaches the thermometer it gives the full limit, by the time the manager has been summoned to see the reading it has dropped below. In one of the mills in which excess of humidity beyond that allowed by law was found, the women were each in charge of twenty looms. The visit had been paid expressly to investigate a complaint that the women suffered from the strain of taking twenty looms each, the automatic Northrop loom being used in this mill. The strain must have been very great, and it was in these circumstances that women were working in an over-steamed atmosphere, the dry bulb being 76°, the wet 73°. In Darwen, Miss Lovibond reported that out of fifty-four humid sheds, ten only were provided with cloak-rooms. The terribly damp state in which she found shawls hanging on damp walls filled her, as well it might, with wonder that highly-organised workpeople have not yet secured for themselves such a necessity as a cloak-room.

Clerks and the Insurance Bill.—The directors of the Scottish Clerks' Association have addressed to the Government and to members of Parliament a letter in which they set forth in detail the various benefits which members of this registered society can subscribe for. "The benefits arranged by the Association," the directors proceed, "are, for a smaller subscription, largely in excess of those provided in the Bill, and are arranged in such a way as to be of the utmost advantage in meeting the special requirements of clerks. The whole position clearly demonstrates that, in dealing with such a class as clerks at least, there is ample justification for providing exceptional treatment under the Bill. It is respectfully suggested, however, that if any person can show, to the satisfaction of the Insurance Commissioners, that he is covered for the amount required under the Bill with any approved society, the management of which is on a satisfactory basis, and which is solvent, he should be granted exemption under section 2 of the Bill." Pointing out that the membership of the Association is now 6,500, the directors suggest that "if clerks are to be included, the number required for an approved society should be reduced." The directors draw attention to the Association's system with regard to medical treatment. The "moderate subscription includes payment of the members' own doctors' bills up to 4*s.* per visit, medicine, proportion of specialists' and operation fees, surgical and medical supplies, surgical fees applicable to dentistry, and medical fees and medicine supplied in sanatoria, hospitals, or nursing homes. The member is allowed to call in the nearest, best, or whatever doctor he chooses, without restriction. The scheme has worked well, and is exceedingly popular with members and doctors alike."

Discovery of Petroleum.—A petroleum spring has been discovered in the Coverage Pit of the Wigan Coal and Iron Company, Leigh. It may be remembered that in 1879, at the Mear Hay Collieries, Longton, Staffordshire, large quantities of oil were obtained under somewhat similar circumstances. The seam of coal from which it welled was nearly 500 yards below the surface. The Lancashire spring has been discovered at a rather greater depth, over 600 yards. The Mear Hay oil was rich in paraffin wax, which at that time was worth about 5*d.* per lb. as compared with the present price of under 2*d.* per lb. The yield was about three hundredweights per ton of oil refined. Some time afterwards, a similar spring was discovered in another colliery about a mile distant from Mear Hay, and was regularly refined until the pit was abandoned owing to the unremunerative character of the coal-seam. The oil was black in colour with a slight tinge of green. It had a sweet odour, and when brought to the surface set hard to a consistency like good yard. This was owing to the large proportion of wax in it. When refined, the oil was pure white, with a specific gravity of about ·895, and gave a fine white light. It is believed by many that the deposits of oil in the district, which has never been thoroughly prospected, are considerable.

The Seamen's Strike.—It is not thought likely that the sailors' strike which began last week will be very serious. It was intended to be international in character, but the foreign seamen have not responded, and it may be expected that before very long the local trouble in the United Kingdom

will have passed. The men seem to have been encouraged to strike by the way in which the Board of Trade has administered the language test, which has considerably reduced the number of seamen in the mercantile marine, but it may be doubted whether the reduction is sufficient to bring about the artificial scarcity necessary if the strike is to succeed. Probably there was no general desire on the part of the seamen to resort to a strike. They have their grievances, and some of them are pressing; but they are not likely to mend matters by refusing to work. The shipowners are too strong for them.

GENERAL NOTES.

THE PRODUCTION AND USES OF MONAZITE.—There is a constant demand for minerals carrying thorium for the manufacture of incandescent gas mantles. A large number of such minerals are known to the mineralogist, though only one, monazite, has been found in quantities large enough to supply the commercial demand. Two other minerals that carry a large percentage of thoria—thorite and thorianite—have been obtained in small quantities from Ceylon. The world's sources of supply of monazite for many years have been Brazil and the United States. The Brazilian output is shipped to Germany, Austria, and the United Kingdom for manufacture into thorium salts. The greater part of the monazite produced in the United States is used in that country, though certain quantities are exported annually. For a number of years past the supply has come from North and South Carolina, but it is probable that Idaho will add materially to the production hereafter. Deposits of monazite exist in other Western States and in Georgia and Virginia.

THE GROWTH OF THE LINER.—The past year has seen a remarkable development in the growth and dominance of the liner, a term not limited to mail and passenger carriers. 1910 saw the launch of the "Olympic," of 45,000 tons, that is now trading between Liverpool and New York; and it saw the "Mauretania" make the run from Liverpool and Fishguard to New York and back, after discharging mails, passengers, and cargo, and reloading cargo, mails, and passengers and 6,000 tons of coal, in just over twelve days. Nor is there any doubt that the triumphs of 1910 will be surpassed in the coming years. Already the Cunard Company has ordered a liner which will be 5,000 tons bigger and two knots swifter than the "Olympic," and the Germans are building a boat of over 50,000 tons. Cargo tramps of 10,000 tons are common, and a tonnage of 20,000 for this class of vessel is talked about. The deepening of ports and harbours has given a great impetus to the employment of these mammoth vessels, for the ton-mile cost of ocean carriage is reduced in proportion to the size of the carrier, if other conditions are suitable. Frequently the owner of the large liner is working at a profit when the owner of the old-type vessel is working at a loss. But it can hardly be said that the profits earned by the great fleets of liners are adequate to the capital invested and the risks incurred. In 1909, twenty-three of the passenger liner companies, with a paid-up capital of £21,211,360, and a debenture debt of £14,462,764, were only able to pay an average dividend of 4·10 per cent., and though they did slightly better last year they only paid 4·85 per cent.

LIBERIAN COFFEE.—The coffee-plant flourishes and reaches a size in Liberia to be found in no other part of the globe. The berries are larger and richer than those produced in any other country, and when properly cured possess the most delicious aromatic flavour. In Liberia two crops are gathered each year, one during the rains and the other during the dry season. The rains begin in April and May and close in October and November. The chief and most important coffee crop is gathered during the dry season, *i.e.*, in the months of December, January, and February. When the coffee is picked the berry is usually crushed in a mill or mortar, and then spread on the ground in the sun in a prepared place until well dried. Every evening the coffee is removed in order to avoid its getting wet from rain or dew. When dried it is beaten in a mortar until all the pulp is entirely separated from the beans. It is finally cleaned by fanning, and some of the planters grade it by removing all broken and undeveloped beans. Liberian coffee is very strong, and is therefore used in Europe to gives strength to weaker coffees. As generally prepared, it has a little bitterness in its flavour, and it is therefore often mixed with other coffees to overcome this.

RUBBER AND GUTTA-PERCHA IN BORNEO.—A great awakening took place in 1910 in regard to the value of the native gums of North Borneo, of which there are four—gutta-percha, gutta-jelatong, gutta-jangkar, and rubber. About the beginning of 1909 a British company obtained a concession from the Raja to control the output of the forests of Sarawak, and a large plant for refining and preparing the gums was erected at the mouth of the Sarawak River, eighteen miles from Kutching. It is estimated that no less than 40,000 acres have been brought under rubber cultivation in 1910 in British North Borneo. This has greatly stimulated the demand for coolie labour, which is brought from Java, Singapore, and Hong-Kong, through agencies at those places. According to Government reports, there are now employed on the various rubber estates about 15,000 coolies. When the trees now being planted become productive, it is estimated that 50,000 coolies will be required. As this estimate is based on real plantings, there is a bright outlook for large expansion in the general commercial condition of North Borneo.

ROYAL SOCIETY FOR THE ENCOURAGEMENT OF ARTS, MANUFACTURES, AND COMMERCE.

William Henry Davison, M.A. ....

Robert Kaye Gray ....

Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc. ....

William Henry Maw, M.Inst.C.E. ....

Principal Henry A. Miers, D.Sc., F.R.S. ....

James Swinburne, F.R.S. ....

Sir Philip Watts, K.C.B., LL.D., D.Sc., F.R.S. ....

Colonel Sir John Smith Young, C.V.O. ....

Treasurers.

(Two to be elected.)

Carmichael Thomas ....

Prof. John Millar Thomson, LL.D., F.R.S. ....

Secretary.

Sir Henry Trueman Wood, M.A.

* Nominated by H.R.H. the President.

N.B.—The names in Italics are those of Members who have not filled the offices for which they are respectively proposed during the current year.

NO BALLOTING LIST can be received unless presented by the Member IN PERSON at the Meeting.

Bye-Law 69.—"Every member *whose subscription is not in arrear*
Bye-Law 83.—"Every member intending to vote at the election o
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Journal of the Royal Society of Arts.

No. 3,058. VOL. LIX.

FRIDAY, JUNE 30, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

ANNUAL GENERAL MEETING.

The one hundred and fifty-seventh Annual General Meeting for receiving the Report of the Council, and the Treasurers' Statement of Receipts and Payments during the past year, and also for the Election of Officers and New Members, was held in accordance with the By-laws on Wednesday last, June 28th, at 4 p.m., Sir John Cameron Lamb, C.B., C.M.G., Chairman of the Council, in the chair.

The Secretary read the notice convening the meeting, and the Minutes of the last Annual Meeting.

The following candidates were proposed, balloted for, and duly elected members of the Society :—

Ahsan-ullah, Khan Bahadur Moulvi, M.A., Nalta, District Khoolna, India.

Bartholomew, James, Blakesley Hall, Northants.

Bloor, Alfred J., Cove Lawn, Stonington, Connecticut, U.S.A.

Broderick, John Carroll, 151, St. James-street, Montreal, Canada.

Brush, Charles Francis, Ph.D., LL.D., 3725 Euclid Avenue, Cleveland, Ohio, U.S.A.

Connell, William F., 16, Court-street, Brooklyn, New York, U.S.A.

Craig, Eustace N., Messrs. D. & C. Rutter, Ltd., Crayford, Kent.

Crockatt, J. R., Lismore, Heathside-road, Woking.

Gray, Edward Dundas McQueen, M.A., Ph.D., Albuquerque, Bernalillo County, and Croftonhill Ranch, Eddy County, New Mexico, U.S.A.

Haq, K. F., Deputy Magistrate, Alipore, Calcutta, India.

Hirata, Tomoh, Consulate-General of Japan, 3, Alipore-lane, Calcutta, India.

Honey, William, Fequixquiapan, Queretaro, Mexico.

Hortvet, Julius, State Dairy and Food Department, Old Capitol, St. Paul, Minnesota, U.S.A.

Howison, Professor George Holmes, M.A., LL.D., 2631 Piedmont-avenue, Berkeley, California, U.S.A.

Humphrey, Professor Harry Baker, Pullman, Washington, U.S.A.

Jaffé, Israel, 24, Osnaburgh-street, N.W.

Keatinge, Sherbrooke Augustus John, M.I.Mech.E., Vineholt, Abbott-road, Lahore, India.

Khan, Raja Haji Saiyed Shaban Ali, Khan Bahadur, Salempur, District Lucknow, Oudh, India.

Lambert, Thomas Stoddart, J.P., 7, Arlington-street, Wellington, New Zealand.

Lindsay, David Colville, Paia Maui, Hawaiian Islands ; and Kingarth, Kirriemuir, Scotland.

MacAllister, Edward B., Rockland, Maine, U.S.A.

Macaulay, Magnus Johannes Oyedele, Blackhall-street, Waterloo, Sierra Leone, West Coast of Africa.

Mason, Miss G. Heather, The Meadow, Grosvenor-road, Reading, Berks.

Merk, William R. H., C.S.I., LL.D., Udimore, Ascot.

Myers, William S., 17, Madison-avenue, New York City, U.S.A.

Pan Wi Yan, 39, Heeren-street, Malacca, Straits Settlements.

Parsons, Hon. Sir Charles Algernon, K.C.B., LL.D., D.Sc., F.R.S., Holeyn Hall, Wylam-on-Tyne, Northumberland ; and 9, Hans Mansions, S.W.

Patiala, His Highness the Maharaja of, Patiala State, India ; and Addison Lodge, 7, Addison-road, W.

Ross, Alexander Carnegie, C.B., M.A., British Consulate, Buenos Aires, Argentine Republic, South America.

Ryerson, Colonel G. Sterling, C.A.M.S., 66, College-street, Toronto, Canada.

Singh, Sirdar Jogendra, Aira Estate, Kheri, India.

Smith, Ian Knighton, B.A., B.A.I., c/o The Chief Engineer, East Indian Railway, Calcutta, India ; and Portmerron House, Dungannon, co. Tyrone, Ireland.

Stovell, Captain Edwin Frederick, Keppel Harbour, Singapore, Straits Settlements.

Subhan, Nawabzada A. K. M. Abdus, Khan Bahadur, Senior Deputy-Magistrate and Collector, Furudpore, E.B.A., India.

Ullah, Muhammad Insha, Office of the *Watan*, Lahore, India.

The CHAIRMAN nominated Mr. G. E. Jones and Mr. H. B. Wheatley scrutineers, and declared the ballot open.

The SECRETARY then read the following—

REPORT OF COUNCIL.

I.—PRESIDENCY OF THE SOCIETY.

The first President of the Society was Lord Folkestone, who served from 1755 to 1761. He was succeeded by Lord Romney, who held office till 1794. In that year he was followed by the Duke of Norfolk, who remained President till 1816. In 1816 the Duke of Sussex was elected, and continued in office till his death in 1843, when the Prince Consort accepted the Presidency. He held the office till he died in 1861. Mr. William Tooke, an old and well-known member of the Society, was chosen to fill the office till the election of H.R.H. the Prince of Wales (King Edward VII.) in 1863. On King Edward's accession in January, 1901, the Presidency became vacant, and Sir Frederick Bramwell, one of the oldest and most distinguished members of the Council, was selected to fill it until H.R.H. the Prince of Wales (King George V.) on his return from abroad, accepted the office in December, 1901. His Majesty's accession again caused the Presidency to be vacated, and the Council nominated the Lord Chief Justice for election at the last General Meeting (June, 1910). Lord Alverstone held office till February last, when he reported to the Council that H.R.H. the Duke of Connaught had consented to accept the office of President, and His Royal Highness was elected by the Council for the remainder of the year. In accordance with the By-laws, the Council have now placed His Royal Highness's name on the balloting list for election as President.

His Royal Highness became a member of the Society in 1871, when he qualified as a life member by the payment of the usual contribution. In the following year (1872) he presided at the Technical Education Conference held by the Society, which started the movement in favour of Technical Education in London. The outcome of this conference was the establishment of the Technological Examinations, and its ultimate result the foundation of the City and Guilds of London Institute.

In 1902 His Royal Highness was nominated by King Edward as a Vice-President of the Society, and he has since been annually re-elected to that office.

II.—ORDINARY MEETINGS.

The Chairman of the Council, Sir John Lamb, chose for the subject of his opening address the association of telegraphy with the Society. This he succeeded in tracing back to 1805, when the silver medal was given for a night and day telegraph, of course of the semaphore order. It was in 1843 that the electrical telegraph came before the Society, for then Cooke and Wheatstone's apparatus was described and worked in the Society's meeting room. Sir John followed the history from that time down to the introduction of sixpenny telegrams, and was able to make out an excellent case, showing how much the Society had done, not only in publishing information, but in promoting the development of telegraphy by the various reforms and advances which from time to time it had urged on the Government of the day.

Besides the opening meeting, there were four Ordinary Meetings before Christmas. At the first of these Sir Henry Cunynghame described the very ingenious and useful device which, when applied to an ordinary safety lamp, renders the detection and quantitative estimation of minute quantities of fire-damp easy and certain. This apparatus has received the official approval of the Home Office, and a circular describing its use, and drawing attention to its value, has been issued by that department.

At the third Ordinary Meeting Mr. Campbell Ogilvie gave a very full and interesting account of the present condition of Argentina, its exports, imports, manufactures, and products. Sir Alexander Henderson, who has been for many years largely interested in British investments in the Republic, mentioned the fact that some hundreds of millions of British capital were now invested in the Argentine, and expressed the opinion that that amount would be doubled in the course of a very short period.

At the next meeting Dr. Vaughan Cornish, who had lately returned from a visit to Panama, gave an account of the recent progress in the construction of the canal, and described the great advances which had been made since the work had been taken in hand by the Government of the United States. Dr. Cornish had visited the canal two years previously, and had had opportunities of making a thorough examination of the works, so that he was in a position to give

the Society a very accurate account of their present condition and recent progress. When Dr. Cornish's paper is taken in conjunction with the paper read in January, 1907, by Monsieur P. Bunau-Varilla, written as it was from a very different point of view, it may be said that the records of the Society now contain very full information of the history and progress of this great work.

The last paper before Christmas dealt with an antiquarian subject, "A New View of Roman London," by Mr. Reginald Smith, of the British Museum. Mr. Smith is a recognised authority on the subject, and the value of the information which he has published in the "Victoria History of London" is generally admitted. Not very much is really known about Roman London; but it is certain that the investigations of Mr. Smith have added considerably to that knowledge.

At the first meeting after Christmas, Mr. J. C. Medd, who had already contributed valuable papers on "Education in the Netherlands" and "Agricultural Education" to the Society, described the work which is now being done in Holland by the Dutch labour colonies, and held up that work as a useful example for imitation in Great Britain. Lord Reay, who presided, from his own personal knowledge of the subject, was able to add a good deal to the information conveyed by Mr. Medd, whose views he thoroughly endorsed.

In his paper on "Motor Transport at Home and in the Colonies," Mr. Horace Wyatt dealt with the character of the motor vehicles required for ordinary rough work in new countries, with bad or undeveloped roads, and strongly advocated suitable motors as a method of opening up new and little-used trade routes.

At the first meeting in February, Mr. Philip J. Hartog, Academic Registrar to the University of London, read a very striking paper on "Examinations," and this was supplemented by an equally valuable communication from the chair by the Earl of Cromer. Both Mr. Hartog and his chairman dealt with the question of competitive examinations, and both were equally conscious of the many drawbacks of the competitive examination system, while it cannot be said that either of them was prepared to recommend a satisfactory substitute. Both the paper itself, and the remarks made by Lord Cromer, may be certainly commended to the attention of all who are interested in the subject.

At the following meeting, Captain Tremearne gave an interesting account, derived from personal experience, of the inhabitants of Northern Nigeria. This was followed by a paper by Mr. George A. Stephen, who was then Chief Assistant-Librarian at St. Pancras, on "Modern Machine Bookbinding." While the subject of artistic bookbinding in leather has been treated at great length in books and lectures, the manufacturing side of bookbinding has rather lacked attention. Mr. Stephen, who has devoted a great deal of attention to cloth bindings, and has produced an excellent book on the subject, dealt as fully with it as the limits of a paper permitted. He described the most modern methods, dwelt on their advances, and pointed out their deficiencies. The perfection with which books are now turned out, and their extreme cheapness, are certainly remarkable results of the application of modern machinery to an ancient and artistic industry.

The question of the presumed power of "dowsers," and the use of the divining-rod, is one that has for the most part been ignored by men of science. Professor Wertheimer, in his paper on "Waterfinders," gave the results of an attempt at a scientific investigation of a very old and very interesting subject. On the whole, it cannot be said that the believers in the divining-rod have had their faith shaken by modern researches, or that modern men of science have been the least moved from their attitude of incredulity.

It was in 1906 that Dr. (now Sir) Thomas Oliver gave the Society a paper on "Bridge Building by means of Caissons, including remarks upon Compressed-Air Illness." The subject was also dealt with by Dr. Scott Haldane in his lecture on "The Hygiene of Work in Compressed Air (Diving, Caisson Work, Sub-aqueous Tunnelling, etc.)," given under the Shaw Trust in November, 1907. At the first meeting in March, Dr. Leonard Hill, who has for many years been working at the subject, brought it up to date in his paper on "Caisson Sickness and Compressed Air." Much has been done in consequence of the investigations, to which Dr. Leonard Hill himself has contributed a very important part, in safeguarding the health of those who work in compressed air, and in lessening the dangers attendant on the conditions under which they work.

At the next meeting, Dr. James Cantlie gave a useful popular account of the methods by which plague is spread, and of the means which ought to be taken to lessen the danger of its dissemination. The manner in which plague is communicated by means of rats and their

parasites is now thoroughly well known, and this knowledge ought in course of time to provide, and it may reasonably be expected will provide, a means for ultimate extinction of the epidemic.

A great deal of attention has lately been drawn to the adulteration of food, and many exaggerated statements about food adulteration have been put forward. A useful account of the facts of the case was given to the Society by Colonel Charles E. Cassal, Public Analyst of the Borough of Kensington. The meeting had the advantage of being presided over by the Lord Mayor of London (Sir Thomas Vezey Strong), who made some very valuable practical remarks as to the action which ought to be taken to ensure the purity of all food products.

At the next meeting, Mr. Arthur Davis gave a thoroughly practical account of "The Manufacture of Portland Cement," which will be found of special interest in view of the increased scope and importance of the applications of this material. At the last meeting in March, Mr. George Heming gave an interesting discourse on "Art Education" as applied to the work of the jeweller and goldsmith. Mr. Heming's paper to a large extent dealt with the useful work which is being carried on by the Goldsmiths', Silversmiths', and Jewellers' Art Council, and laid much stress on the importance of raising the standard of work by the education of the handicraftsmen and the discouragement of the use of machinery.

Mr. Henry L. Heathcote's paper on "Wheels, Ancient and Modern" covered a wide subject, and showed what a remarkable development has taken place, and how much progress has been made in the growth from the elementary disc of wood, which served as a wheel, to the scientifically-constructed piece of mechanism which is now employed for bicycles and for motors.

The paper read at the next meeting, by Mr. Noel Heaton, on "The Production and Identification of Artificial Gems," was of extreme interest. Probably not many persons are aware that rubies and certain other precious stones can now be actually manufactured, that is to say, that rubies, not merely imitations, such as for long have been in use, but identical in chemical composition and in other characteristics with the natural stones, can be produced as an article of commerce. The manufactured stone can indeed be identified by certain peculiarities consequent on the nature of its crystallisation: in fact, it would not be too much to say that the artificial stone is a little more perfect than the natural one, which has certain characteristics, or indeed defects, which enable the two to be distinguished. Mr. Heaton's description of the whole process of manufacture was extremely clear and full, and the paper was specially valuable as a record of the success which has now been attained in the process of manufacture.

The question of London transport has been before the Society in various forms, notably in the two addresses delivered by Sir John Wolfe-Barry in 1898 and 1899, when he was Chairman of the Council, and in the paper read here by Captain Swinton in 1906. Mr. A. W. Gattie approached the subject from a different standpoint, and described a scheme which he has worked out for the distribution of goods of every character (with the exception of cattle and coals), by means of a Clearing House similar in principle to the Clearing House first employed by bankers, and afterwards by railway companies, for dealing with cheques and with railway traffic. Mr. Gattie's scheme is a large and comprehensive one. It was put forward very clearly in his paper, and the discussion upon it helped still further to bring out the various points involved.

In 1905 Mr. Sigmund Stein read a paper here on "The Manufacture of Sugar from British-grown Beet." Mr. Hal Williams, in his paper on "Beet-Sugar Factories," did not attempt to discuss the whole problem, but merely described the mechanical arrangements which had been found serviceable in other countries for the manufacture of sugar from beet. It was a valuable contribution to an important controversy, and the information contained in it will be of considerable value to those who are now endeavouring to create this important industry in England, if, as may be hoped will be the case, they succeed in establishing, at all events, an experimental factory.

The last two meetings of the session were notable, because in both cases the papers were read by distinguished foreigners. On May 17th, Professor Raoul Pictet came over from Berlin to read a paper on "Low Temperatures," and on May 24th Mr. Frank M. Andrews came specially from America to read his paper on "American Architecture." Professor Pictet has attained a world-wide reputation as one of the first to succeed in liquefying certain of the so-called permanent gases—those gases, that is to say, which had been unliquefied in the earlier experiments of Faraday. This was as far back

as 1878. Since that time Professor Pictet has been working steadily at the subject, and though other physicists, notably Sir James Dewar, have carried still further the investigations in which he was the pioneer, he has always continued his original work, and has done much to advance our knowledge of the subject. In his paper he gave a very full account of his researches, and of the speculations which he had founded upon them. His principal results were obtained in connection with the effect of low temperatures upon chemical reactions. By continuous experiments he was enabled to ascertain the precise temperature at which any special reaction ceased to occur, and in his opinion it was possible by varying the temperatures to control, and, to some extent, to vary the nature of the reaction itself. Passing on from chemistry, he discussed the application of thermodynamics to physics, and even to biology, and it may be taken for granted that the speculations which he initiated will afford ample material for future discussion and consideration.

Mr. Andrews' paper on "American Architecture" dealt specially with the treatment to which American architecture has been subjected —the production of enormous buildings occupying a limited ground area. It appears certain that this style of architecture was initiated by the fact that New York, cramped within the narrow limits of Manhattan Island, and unable to extend laterally, found it only possible to extend vertically, and her architects were therefore compelled to consider methods of accommodating the greatest possible amount of buildings on the very smallest amount of space. From this standpoint Mr. Andrews traced the growth of a genuine style of American architecture, and claimed for his country that it was now doing what the older civilisations had failed to do, namely, to develop an individual style of architecture for itself. The interest of the paper was augmented by a very fine collection of lantern-slides of American buildings of every sort.

III.—Indian Section.

The papers read in the Indian Section numbered, as usual, six.

The series of descriptive papers on the various Presidencies and Provinces that was instituted ten years ago continues to be appreciated. In the case of a huge country, or rather congeries of countries, so complex as India, a method of detailed treatment has necessarily many advantages, and these ably-written papers seem specially calculated to promote that better understanding of our great Dependency which the Section, since its establishment, more than forty years ago, has always kept in view. The first of the papers referred to related to Madras, one of the largest and oldest of the British settlements; the latest, read on May 25th, by Mr. W. R. H. Merk, dealt with the North-West Frontier Province, the smallest and one of the youngest of the Provinces, indeed the youngest of all if Eastern Bengal be excepted. Unlike any other administrative unit in the Indian Empire, the Province described by Mr. Merk, its late Chief Commissioner, comprises two totally distinct and dissimilar forms of jurisdiction. Only a third of the area, or some 13,000 square miles, is under full British law and administration; the remainder is occupied by warlike tribes, who, although under complete British "political control," have been permitted to retain their independence so far as internal and municipal affairs are concerned. The one thing, from a political point of view, to which the border tribesmen are passionately attached and for which they will fight to the end, is their domestic or municipal freedom. In the adoption of the dual system lies, in Mr. Merk's judgment, the solution of the problem of the borderland. Since 1901, when the Province was called into existence by the then Viceroy, Lord Curzon, there have been only two military expeditions, "each of the shortest duration—'week-end wars.'" In the previous sixty years there were fifty-six frontier campaigns. Significant though these figures appear to be, Mr. Merk observes that too much reliance cannot be placed upon them, since, owing to the recent arming of the tribes, "we may have, at any moment, to reassert our strength." On the other hand, many indications of a change for the better are seen. One of several striking instances mentioned in the paper is that of the Kohat Pass. At either end of the Pass lie the important garrisons and civil headquarters of Peshawar and Kohat. Many attempts to construct a much-needed metalled road were baffled by the tribesmen, who thought that if the road came their internal independence would go. More recently the case was put to them again. An officer in whom they trusted—and Mr. Merk tells us that the Pathans are specially susceptible to personal influence—succeeded in convincing them that their fears were groundless; they accepted the road, assisted to construct it, and "where formerly one had to pick one's way on horseback over the boulders of a torrent bed,

one motors now in a couple of hours from Peshawar to Kohat."

The mineral resources of India, to the importance of which attention was called in a paper read before the Section as far back as 1873, have been adequately described in official publications issued during Sir Thomas Holland's term of office as head of the Geological Survey (1903–9). The comprehensive and valuable paper—"The Trend of Mineral Development in India"—which the late Director of the Geological Survey read on April 27th, consisted of an exhaustive examination of all the facts essential for a fair discussion of the political lessons to be derived from recent experience. The rules adopted under Sir Thomas Holland's directorship removed most of the undesirable restrictions then in force, and further relaxations are now under consideration. These, it is hoped, will meet complaints as to delays in disposing of applications for concessions—delays largely due to excessive caution on the part of district officers in interpreting the regulations, and not to sheer wilfulness. Sir Thomas Holland suggests caution in the export of the country's inorganic products, or some of them, and urges that the time is coming when the mineral question will be to India, in its geographically isolated position, one of the greatest of its political questions. Not remotely connected with the signs of a great industrial awakening in India, is the subject which was brought forward by Mr. Reginald Murray in his able paper on "Banking in India." He contrasted the conditions of trade finance, prior to the introduction of joint-stock banking, with the present state of things, and demonstrated the necessity for an extension of the machinery for attracting and distributing capital to meet the increasing wants of the country. Though there are indications of vigorous growth, banking in India a hundred years after the first joint-stock bank was established is, he maintains, at present in its swaddling-clothes. The paper also inquired into the causes which have contributed "to set-back India's credit in the City of London," and it was contended that India as a field for the profitable and secure employment of sterling capital offers much greater opportunities than have been recognised hitherto by the London market. The chairman of the meeting, Sir Felix Schuster, in a weighty speech, differed to some extent from Mr. Murray's conclusions as to the supposed "set-back." In common with other "gilt-edged" securities, and for similar causes, the price of Indian stock has fallen, but not, Sir Felix Schuster declares, proportionately more than that of British Consols. Given a period of rest and freedom from political agitation, both in India and at home, this eminent financial authority feels confident that, with the development of the railways, with the benefits bestowed by irrigation, with the care of the Government for the well-being of all classes, the commercial development and prosperity of the country in the next ten to twenty years will be such as are almost undreamed of at the present time.

In his admirable paper on "Education in India," Mr. Claude H. A. Hill dealt with one particular feature of the problem of Indian education—religious or moral training. After sketching the history of the connection of the Government with the promotion of education, and of the direction in which their ideas respecting moral instruction were moulded, he explained the attitude of the Indian mind towards education and religion, and argued in favour of a reconsideration of our policy of rigid secularisation. Finally, he offered suggestions as to the methods by which the change he advocates may be effected with the least difficulty and risk. Favourable reference was made both in the paper and in the discussion to the work in regard to India which is being quietly done by the Moral Education League.

Mr. Robert F. Chisholm, in his very interesting illustrated paper on the Taj Mahal, endeavoured to show that the secret of the charm of this famous monument lies in the adaptation by its unknown designer of "a studied and systematic system of heightening the deep shadows and avoiding all those black patches which destroy a sense of distance."

Mr. R. A. Leslie Moore, in his excellent and non-critical paper on "Indian Superstitions," related and commented upon a very large number of curious domestic beliefs prevalent in India, particularly that part of India with which he is most acquainted, the Presidency of Bombay. Popular beliefs of this character vary in different parts of the Peninsula, and Mr. Moore's examples were supplemented by speakers with experience of Bengal, Madras, the United Provinces and the Punjab.

IV.—Colonial Section.

The session opened on November 29th with what may be called an official paper on "The Progress and Prospects of Mining in Western Australia." Its author, Mr. A. Montgomery, M.A., F.G.S., is the principal adviser on mining

affairs to the Government of Western Australia, and at the outset of his elaborate paper he acknowledged the indebtedness of that State and of himself to the Society for affording him an opportunity, during his visit to England, of addressing an audience in the heart of the Empire on one of the leading industries of so distant a member of the Imperial body. *Inter alia*, he discussed the causes of the hostility that for some years has prevailed in the London market towards Western Australian mining ventures. One of these causes is the failure of so many companies in the earlier days of the goldfields. Various criticisms of the mining policy of the Government were answered, and, finally, attention was called to the "exceptionally good opportunities offered by Western Australia to capital for legitimate mining operations, and also to men who have to depend on their own physical efforts to make their living for doing so either in mining or in farming pursuits." The late Governor of the State (Admiral Sir Frederick Bedford) and the Agent-General for Tasmania (the Hon. Sir John McCall, M.D.) were among those who took part in the discussion.

"The Tin Resources of the Empire" was the title of a very able paper read on January 31st by Mr. F. Douglas Osborne, M.Inst.M.M. Mr. Osborne occupies in the Federated Malay States a position similar to that filled by Mr. Montgomery in Western Australia, and therefore he spoke from personal knowledge of the principal source of the tin supply. Out of a total production of 104,250 tons in 1910, the contribution of the British Empire was 72,450 tons, the share of the Straits Settlements amounting to 58,500 tons. Although the paper was largely devoted to the Malay Peninsula, the other tin-fields, including the famous workings in our own country, were surveyed as far as the available data permitted. With regard to Cornwall, it was pointed out that the annual output has fallen from 14,000 tons to an average of 4,800 tons, and no prospect of an improvement was held out by Mr. Osborne. On the other hand, Mr. J. H. Collins, and the other representatives of the western Duchy who spoke, maintained that the present condition of the industry is due merely to temporary causes, and that when these are removed the Cornish mines will be almost as remunerative as ever they were. Mr. Osborne's paper is one of the series recently begun in the Colonial Section, with the object of dealing separately with the more important commercial products of the Empire.

The Secretary of State for the Colonies, the Right Hon. Lewis Harcourt, M.P., presided at the next meeting (February 28th), when the Hon. Sir Richard Solomon addressed the Society on "The Resources and Problems of the Union of South Africa." While the history of the material progress of South Africa since the first discovery of gold, forty years ago, has been substantially a history of mineral development, the High Commissioner thinks that an era of great agricultural prosperity has now commenced, and he predicts that before many years have elapsed the Union, in addition to being a rich mineral country, will be "one of the principal agricultural countries of the world." In his lucid and statesmanlike utterances on the problems confronting the Union, he took a hopeful view of the future relations of the English and the Dutch inhabitants. "The fact that the children of both races now attend the same schools and grow up together will make the next generation of men and women free from racial feeling." As to the most serious of all the problems—the Native Question—he submitted that no man living to-day can forecast its ultimate solution. A sound native policy must be slowly and naturally developed, and in that development the only course in his opinion is to "adhere to the good sound principle of justice and toleration." The discussion was opened by the Right Hon. Sir Walter Hely-Hutchinson who, in an eloquent speech, associated himself with all Sir Richard Solomon said regarding the future of the two white races in South Africa. The other speakers were the Duke of Argyll, Lord Blyth, Chairman of the Colonial Section, who recently visited South Africa at the request of the late Government of the Cape Colony to report to them on the prospects of the viticultural industry, Sir David Gill, and Mr. P. J. Hannon.

On April 4th Captain R. Muirhead Collins, R.N., C.M.G., read before a large and distinguished audience a very useful paper on "The Commonwealth of Australia." The world, he declared, has no parallel for the changes that have been brought about in that Continent since the federation of the six States—New South Wales, Queensland, South Australia, Tasmania, Victoria, and Western Australia—eleven years ago. In short, Australia is embarking on a new era in Local and Imperial politics, in Primary and Secondary Industries, in Defence, and in her relations to the outside world. The importance

of the occasion was enhanced by the presence in the chair of Lord Denman, as this happened to be his lordship's earliest appearance at a public gathering since the announcement of his appointment as Governor-General of the Commonwealth.

At the concluding meeting, held under the presidency of the Duke of Argyll on May 9th, Mr. F. Williams Taylor read a most interesting paper on "Canada and Canadian Banking." He began by sketching the great Dominion province by province. He then described its excellent banking system, largely the handiwork, as he pointed out, of Scottish settlers, and showed how much that system has assisted in the wonderful commercial development of the country. To meet the financial requirements of the Dominion, there are altogether twenty-nine banks, with 2,500 branches, the paid-up capital and reserve being £28,000,000. The discussion on Mr. Williams Taylor's paper was one of the best of the session, the speakers including, besides the Duke of Argyll, those veteran Canadian statesmen, Lord Strathcona and Sir Charles Tupper, as well as Sir Felix Schuster and the American Consul-General (the Hon. J. L. Griffiths).

V.—Cantor Lectures.

There were five courses of Cantor lectures given during the past session, and the subjects dealt with were as varied as usual. Three of them were distinctly technical, namely, the courses by Mr. Darling, Professor Brown, and Professor Fleming.

In his course on "Industrial Pyrometry," Mr. C. R. Darling gave a very full and clear account of the whole subject, including its history from the earliest attempts to measure high temperatures and the first crude pyrometer of Wedgwood down to the development of the very beautiful and accurate instruments which enable modern manufacturers to measure with certitude the precise degrees of temperature required for the manufacture of pottery, glass, iron and steel, and for other processes in which extremely high temperatures are required. It is a point which may be noted with some interest that it is almost true to say that during very recent times the thermometric scale has been enlarged from a range extending merely from the solidification to the vaporisation of water, to one reading from the absolute zero of temperature (−273° C.) up to, say, 1500° C.; that is to say, a scale of 100° Centigrade, from 0° to 100°, has been enlarged to a scale of nearly 2000°, from −273° C. to +1500° C. or thereabouts. It is not of course meant to suggest that temperatures below 0° and above 100° were not recognised when the first thermometer was constructed, but only that the accurate measurement of temperatures much outside the scale was impossible.

Professor Adrian Brown's course on "Brewing" may be said to have dealt with the chemistry of that subject as it has advanced from the admirable course of lectures given by Dr. Graham thirty-seven years ago, in 1873–4. One of the points on which Professor Brown laid special stress was the character of the barley which was required by the brewer. He described the present position of knowledge regarding the characteristics of malting barley, and gave the results of recent experiments in barley cultivation in Ireland and elsewhere. He showed that it was now pretty well known what the characteristics required were, and how they could be obtained, so that it remained for farmers to produce the grain best suited for the purposes of the brewer.

Professor John Fleming has already given three courses of Cantor lectures to the Society on electrical subjects. The course this session was on "Applications of Electric Heating." He described and discussed the laws of electric heating, the appliances and processes involved, the application of electric heating to industrial purposes, and finally domestic applications of electric heating. In respect of the latter, the advantages for many purposes are very great; but, at all events, as regards London, until electrical energy can be obtained at a lower rate than that at which it is at present provided, the use of electricity for such purposes as cooking and the warming of rooms must remain a somewhat costly luxury.

Of the other two courses of Cantor lectures, one was artistic, that in which Mr. Frederick Wedmore dealt with "Etching." Two lectures were devoted to the subject—one dealing with the "Old Masters" and the second with "Modern Etching." Both were extremely interesting, and were much appreciated by a numerous audience.

The last course this session was of a more purely scientific nature than its predecessors. Dr. Alfred Tutton devoted four lectures to a description of the structure of "Rock Crystal," and its practical applications. The whole subject of crystallisation and crystallography is an extremely complex one, but it was very clearly dealt with by Dr. Tutton, who availed himself to the full of the opportunities for

experimental illustration offered by the projecting polariscope. Perhaps no more beautiful illustrations can be offered to an audience than those which are provided by the suitable application of polarised light. Dr. Tutton was also able to exhibit to his audience a selection from the magnificent collection of objects constructed from rock crystal in the possession of Mr. Alfred Simson, a member of the Society, who very kindly lent some of his finest specimens for the purpose. In the last lecture an interesting collection of chemical and other apparatus made of fused silica was also exhibited.

VI.—Juvenile Lectures.

There are perhaps few more wonderful applications of photography to scientific research than its application to the study of drops and splashes. No one has carried this research so far as Professor Arthur Worthington, and the audience which came to the Juvenile Lectures last Christmas were fortunate in getting a full exposition of this very remarkable scientific application of photography from the acknowledged master of the subject. Professor Worthington not only showed the long series of marvellous photographs which he has secured, each of them taken with an exposure of about two-thousandths of a second, but exhibited the apparatus which he used, including the ingenious device for regulating the precise instant of illumination by the electric spark at the various stages of the fall of the drop, or the production of the splash.

VII.—Albert Medal.

The Council of the Society, with the approval of His Royal Highness the President, have awarded the Albert Medal of the Society for the current year to the Hon. Sir Charles A. Parsons, K.C.B., LL.D., D.Sc., F.R.S., for his experimental researches into the laws governing the efficient action of steam in engines of the turbine type; and for his invention of the re-action type of steam turbine and its practical applications to the generation of electricity, the ventilation of mines, blast-furnace work, ship propulsion, and other important purposes. The beneficial results which have followed upon these inventions include a cheapening of the production of mechanical power, greater economy and speed for steamships, and the first successful solution of the problem of rotary engines which long had baffled many other inventors.

The problem of design for rotary engines had long engaged attention, and the idea of utilising the flow of steam and its impulse in producing rotary motion had been applied in various forms by a great number of inventors. Sir Charles Parsons, before completing his course of study at the University of Cambridge, had begun to work on this subject, and had designed an epicycloidal engine, of which several examples were made and set to work. Subsequently he undertook a long series of experimental researches into the action of steam-jets, and the methods of utilising the energy possessed by such jets, finally reaching the conclusion that the best results would be obtained by splitting up the fall in pressure in the steam over a great number of wheels or turbines in series rather than in following the impulse-principle, which had previously been generally favoured. Sir Charles began the construction of these reaction turbines in 1884, the first applications being for the purpose of electrical generation. About ten years later he undertook the construction of the first turbine-propelled steam vessel, the "Turbinia." The result of his continuous work, extending over the last twenty-seven years, has been a practical revolution in steam machinery both on land and on sea. Very great economies have been obtained in the production of mechanical power and in the cost of upkeep of steam engines. The cost of electrical energy has been reduced. The efficiency and speed of steamships has been greatly enhanced, and results have been obtained which would have been impossible with the best engines of the reciprocating type. The importance of the discoveries made by Sir Charles Parsons has been recognised and utilised throughout the world, and the rapidity and extent of the applications of the new type of engine have far surpassed any corresponding change in the history of mechanical invention.

VIII.—Medals.

The Council have awarded the Society's Silver Medal to the following readers of papers during the Session 1910–11.

At the Ordinary Meetings.

Campbell P. Ogilvie, "Argentina from a British Point of View."

Vaughan Cornish, D.Sc., F.G.S., F.C.S., "The Panama Canal in 1910."

Reginald A. Smith, B.A., F.S.A., "A New View of Roman London."

Philip Joseph Hartog, M.A., B.Sc., "Examinations and their Bearing on National Efficiency."

George A. Stephen, "Modern Machine Bookbinding."

Dr. Leonard Hill, F.R.S., "Caisson Sickness and Compressed Air."

James Cantlie, M.A., M.B., C.M., F.R.C.S., D.P.H., "Plague and its Spread."

George B. Heming, "Art Education in the Jewelry, Goldsmithing and Allied Trades."

Professor Raoul Pictet, "Les Basses Températures."

Frank M. Andrews, "Architecture in America."

In the Indian Section.

Robert Fellowes Chisholm, F.R.I.B.A., F.S.A., "The Taj Mahal and its Relation to Indian Architecture."

Reginald Murray, "Banking in India."

Claude Hamilton Archer Hill, I.C.S., C.S.I., C.I.E., "Education in India."

Sir Thomas Henry Holland, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India."

W. R. H. Merk, C.S.I., LL.D., "The North-West Frontier Province of India."

In the Colonial Section.

A. Montgomery, M.A., F.G.S., "The Progress and Prospects of Mining in Western Australia."

F. Douglas Osborne, M.Inst.M.M., "The Tin Resources of the Empire."

Captain R. Muirhead Collins, R.N., C.M.G., "The Commonwealth of Australia."

F. Williams Taylor, "Canada and Canadian Banking."

Of recent years it has been the practice that no medals should be awarded to readers of papers who had previously received medals from the Society. Acting on this rule the Council were precluded from considering the papers by Mr. John C. Medd, M.A., on "The Dutch Labour Colonies," and by Mr. Noel Heaton, B.Sc., on "The Production and Identification of Artificial Gems." The Council, however, desire to express their high appreciation of these papers by thanking their authors for them.

The Council have always felt themselves precluded from awarding medals to members of their own body, and they, therefore, could not offer one to Sir Henry H. Cunynghame, K.C.B., for his paper on "Methods of Detecting Fire-Damp in Mines," or to the Hon. Sir Richard Solomon, K.C.B., for his paper on "The Resources and Problems of the Union of South Africa." They had, however, much pleasure in recording their sense of the value of these papers by passing a special vote of thanks to their authors.

IX.—Fothergill Prize.

In former Reports of the Council, the conditions have been set forth under which a gold medal, or a prize of £20, was offered for rescue apparatus for use in mines. The prize was offered for the best portable apparatus or appliance for enabling men to undertake rescue work in mines or other places where the air is noxious, the object being to encourage the production of a rescue apparatus which would enable a succouring party to reach men cut off —in case of mining accidents—by irrespirable gases, or overcome by them. It was known that many such appliances existed, but it appeared uncertain which of them were the best, or even which were of practical use.

The report of the Committee appointed by the Council to consider the apparatus submitted appeared in the *Journal* of the 16th inst., and it is only necessary to record here that, in accordance with the recommendations of that report, the Council have awarded the following prizes:—

A gold medal to Mr. H. A. Fleuss, for the apparatus submitted by Messrs. Siebe, Gorman & Co.

A gold medal to Mr. W. E. Garforth, in recognition of his efforts to perfect and to secure the adoption of rescue apparatus in mines.

A silver medal for the "Draeger" apparatus submitted by Mr. Richard Jacobson.

A silver medal for the "Meco" apparatus submitted by the Mining Engineering Company.

The Council trust that the awards may encourage the recipients to persevere in their efforts to produce a thoroughly trustworthy apparatus, the need for which is constantly becoming more and more evident. In the meantime, they are satisfied that any one of the four systems commended by the Committee is capable of rendering very valuable aid in cases of accident, and they trust that one or other of them will be adopted without delay by colliery owners throughout the country.

X.—Owen Jones Prizes.

After the death, in 1874, of Owen Jones, the well-known decorator and writer on decoration, a committee was formed to collect subscriptions for the purpose of founding a memorial, and the balance (a sum of £400) was presented to the Council of the Society of Arts upon condition of their expending the interest thereof in prizes to "Students of the Schools of Art who, in actual competition, produce the best designs for Household Furniture, Carpets, Wall-papers

and Hangings, Damask, Chintzes, etc., regulated by the principles laid down by Owen Jones." The prizes have now been awarded annually since the year 1878 on the results of the annual competition of the Science and Art Department, and its successor, the Board of Education.

Six prizes were awarded last session (1909–10), each prize consisting, in accordance with the regulations prescribed for the administration of the Trust, of a bound copy of Owen Jones's "Principles of Design," and a bronze medal.

Four hundred and forty-one works from 164 competitors were considered by the Examiners. In the previous year, 192 competitors submitted 481 works for competition.

In their report for 1910 the Examiners state: "Among the 441 works sent in for this competition were a number of designs without any merit whatever; some were so bad as to be unfit for submission in any competition, a considerable number of these coming from one school. The most successful attempts were found among the Woven, Printed, and Stencilled Fabrics. The Designs for Furniture were not thoughtfully considered from the point of view of the principles laid down by Owen Jones. There were some promising specimens of Tiles, Plaster work, and Embroidery."

The list of the successful candidates has already appeared in the *Journal*.*

The *Journal* of January 20th, 1911, contained an interesting analysis of the results of the competition, showing the various successes of the Schools of Art whose students had taken prizes. In all, the Macclesfield School of Art obtained 33 awards; the Manchester Cavendish Street School, 30; Glasgow, 24; Nottingham, 14; and the various London schools, 30. Twenty-eight other schools gained among them 64 awards.

XI.—North London Exhibition Trust.

For some years past the interest on the sum of £157, the surplus of the North London Exhibition held in 1864, has been devoted to the award of prizes to students of the Artistic Crafts Department in the Northampton Polytechnic Institute, Clerkenwell. At present an annual sum of £5 is placed at the disposal of the Governors of the Institute. Of this amount £4 has been expended. The prizes for the present year are to be awarded as follows:—

First Prize of £3, William Ingleton, for a tea service in copper, consisting of teapot, cream jug, and sugar basin.

Second Prize of £1, Henry William North, for a specimen of bookbinding (finishing).

The awards have been made on the recommendation of Mr. Alan S. Cole, C.B. In previous years the works were always adjudicated upon by the late Mr. Lewis Foreman Day.

XII.—Examinations.

As in recent years, it is proposed to postpone any detailed report on the year's examinations until the results have all been issued. The results of Stage III. (Advanced) have just been issued. Those of Stage II. (Intermediate) will be published in July; and those of Stage I. (Elementary) in August.

The total number of papers worked was 34,260, the number last year being 30,852, an increase of 3,408. These were divided among the various Stages as follows:—Stage I., 14,302; Stage II., 14,026; Stage III., 5,932. The corresponding figures for 1910 were:—Stage I., 12,720; Stage II., 12,847; Stage III., 5,285.

A painful incident connected with the examinations was the prosecution of two teachers for fraudulently obtaining prizes at the Society's examinations. The Council were released from the duty of carrying on the prosecution itself by the action of the Public Prosecutor, who considered the question of sufficient public importance to justify his undertaking the prosecution. The Council feel that the Society is much indebted to him for his action, as it was far more satisfactory that the duty should be undertaken by the proper public official rather than by the Society itself. A full report of the proceedings has already appeared in the *Journal*. The only comment to be made upon them is that it is earnestly hoped that the example made will deter others from attempting similar frauds.

It is obvious that the system of the Society's examinations—a system which has been adopted by all the other public examining bodies—lends itself quite easily to fraud, if the members of the Local Committees and the Superintendents of the examinations, upon whom the Society is bound to rely for the satisfactory discharge of their duties, betray their trust. One principal element of value in the Society's system is the low cost of the examinations. Its examinations are appreciated by, and are serviceable to, a very large number of persons of a class quite unable to pay high fees, and the fees, varying as they do from 2*s.* 6*d.* to 1*s.*, are kept down to the very lowest point consistent with the efficient

* See *Journal*, Vol. LVIII., p. 779, July 15th, 1910.

carrying out of the system. The funds at the disposal of the Society are not sufficient to permit any considerable expenditure, and without such expenditure it is impossible to introduce many improvements which might be effected, if so strict an economy were not necessary.

Failing paid assistance, the Society is forced to rely, as it has done for more than half a century, upon voluntary aid, and in almost every case it has been found that such aid is efficient and trustworthy. But the development and competition between the various proprietary institutions which have sprung up of late years, and which it may be added are doing very efficient service in the cause of education, has produced a source of temptation amongst those interested in such institutions, who are anxious to obtain all possible credit for their own schools, and may occasionally be led away to attempt to obtain such credit by illegitimate means. The inducements to such a course of conduct are very small, the prizes are of a trifling amount, and practically neither they nor the certificates are of much value to those who gain them by improper means, except for the swelling of the list of successes of their schools. Sooner or later detection is inevitable, because such fraudulent proceedings cannot be carried out without its becoming the common knowledge of the students and others connected with the establishment that they are going on, and, as in the case which has caused so much annoyance and trouble to those connected with the Society's examinations, attention is drawn to the matter by some unsuccessful candidate or teacher. The Council are now considering very carefully the possibility of devising further checks on dishonest candidates or teachers, but they are satisfied that such dishonesty is very rare, and on the whole they believe that they may still rely on the co-operation of those for whose benefit the whole system is carried on, for the preservation of its genuine character.

XIII.—Practical Examinations in Music, 1910.

The Practical Examinations in Music were not concluded last year until July 2nd, too late for the results to be included in the Report of the Council. They lasted for nine days.

The examinations were conducted by Dr. Ernest Walker, M.A., and Mr. Burnham Horner.

The system of examination was the same as that for recent years. For instrumental music certain standards are given, and candidates are asked to select for themselves which of these standards they choose to be examined in. The standards range from easy to very difficult music. For each standard a list of music is given for study, and from this list candidates select the pieces they will sing or play. Candidates are expected to play or sing the pieces which they have prepared, to play or sing a piece, or portion of a piece, at sight, and to play certain scales.

In all, 351 candidates entered, and of these 339 were examined, a decrease of 53 as compared with last year. There were 268 passes and 71 failures.

The following were the subjects taken up:—Piano, singing, violin, violoncello, clarinet, and viola; 264 entered for the piano, 204 of whom passed; 64 entered for the violin, of whom 56 passed; 1 entered and passed for the violoncello; 8 entered for singing, of whom 5 passed; 1 entered and passed for the clarinet, and 1 for the viola. Two medals were awarded.

The Examiners reported that the quality of the work was about the same as in recent years. There were not a few candidates who gave evidence of talent and good training; others, however, had received only slight preparation. Many pianists, who played the mere notes quite accurately, lost ground through deficiencies of touch and of general technical polish, to the cultivation of which teachers might with advantage pay special attention. Candidates were also warned against attempting music too difficult for their present attainments.

XIV.—Practical Examinations in Music, 1911.

The Practical Examinations for the present year have not yet been held. They will commence on July 1st, and will be finished on July 10th, after which a summary of the results will be given in the *Journal*. The work of the examination is being carried out by the same examiners as in the last eight years; 289 candidates have entered for the present examinations, a decrease on last year of 62.

XV.—Viva Voce Examinations in Modern Languages.

Up to the present date sixteen examinations have been held this year in London, Birmingham, Guernsey, Liverpool, and Manchester. Arrangements have also been made for holding examinations at several other centres.

At these examinations 369 candidates presented themselves, of whom 290 passed (ninety with distinction) and seventy-nine failed. The languages taken up were French, German, and Spanish.

The results of previous years are as follows :—

Year.	Number Examined	Passed.	Failed.
1902	280	202	78
1903	456	324	132
1904	540	375	165
1905	681	502	179
1906	644	469	175
1907	629	476	153
1908	615	467	148
1909	656	506	150
1910	642	495	147

These examinations are held at any of the Society's centres where the necessary arrangements can be made, at any date convenient to the local committee. The examination includes dictation, reading, and conversation, and is so arranged as to test efficiency in a colloquial knowledge of the language, without laying too much stress on minute grammatical accuracy. Candidates who are reported upon as highly qualified by the examiners receive a certificate of having passed with distinction.

The examiners are Mr. S. Barlet and Mr. B. M. Nevill Perkins for French, Professor H. G. Atkins and Professor A. Johannson for German, Professor R. Ramirez and Mr. W. F. Bletcher for Spanish, and Mr. Luigi Ricci for Italian.

XVI.—The Society's Medal.

In 1849 permission was obtained from H.R.H. Prince Albert, who was then President of the Society, to use his head on the Society's medal, and a die for the purpose was made by W. Wyon. This medal was employed up to 1861. After the election of King Edward VII., then H.R.H. the Prince of Wales, to the Presidentship in 1863, his head was placed upon the obverse of the medal, the die being also made by W. Wyon. In 1900, the old die being worn, a new die was engraved at his Majesty's desire by Mr. Emil Fuchs. In 1901, when King Edward succeeded to the throne, and became Patron of the Society, he acceded to the request of the Council that his head should still appear on the Society's medal, and this was done, the necessary alteration being made in the inscription.

On the accession of King George V., when he resigned the Presidency and became Patron, he was asked by the Council if he would allow his head to be engraved on the medal. His Majesty graciously consented, and expressed his wish that the work should be executed by Mr. Bertram Mackennal, A.R.A. Mr. Mackennal has prepared an excellent model of his Majesty's profile, and a die is now being made from this by Mr. Allan Wyon.

XVII.—William Shipley's Tomb.

In the course of some investigations which were being made by the Secretary into the history of William Shipley, to whose exertions was due the foundation of the Society, it was brought to his notice that Shipley's tomb at Maidstone, in the churchyard of All Saints, was in an extremely bad state, and at the suggestion of Mr. J. H. Allchin (Chief Curator of Maidstone Museum and Public Library), and of Mr. Herbert Monckton (Town Clerk of Maidstone), he asked the Council to authorise its repair. This has now been done at the Society's expense.

An account of Shipley was included in the article on the foundation of the Society, which appeared in the *Journal* of the 9th inst.

XVIII.—Conversazione.

The annual conversazione of the Society was held, by the kind permission of the Trustees of the British Museum, in the galleries of the Natural History Museum, South Kensington, on Tuesday evening, May 30th. An account of the conversazione appeared in the *Journal* of the 2nd inst.

XIX.—New Council.

In accordance with the By-laws, the following Vice-Presidents retire by seniority :—Sir William Abney, Sir Steuart Colvin Bayley, Colonel H. C. L. Holden, and Sir Aston Webb. H.R.H. the President has nominated Sir Steuart Colvin Bayley for election as a Vice-President, and also the Duke of Abercorn and the Lord Chief Justice, who were nominated by King Edward and King George when they were Presidents of the Society. To fill the four vacancies, the Council now propose Sir William Lee-Warner, who is already a member of the Council, the Hon. Sir Charles Fremantle, Sir John Wolfe-Barry, and Sir Westby B. Perceval, all of whom have seen long service on the Council and retired last year.

There are four vacancies among the ordinary Members of Council caused by the retirement of Mr. T. J. Bennett, Mr. W. C. Knight Clowes, Sir William Lee-Warner, and Colonel Sir Colin Scott-Moncrieff. To fill these vacancies the Council suggest the names of Mr. William H. Maw, a Past-President of the Institution of Mechanical Engineers and also a Past-President of the British Astronomical Association; Mr. George Ranken Askwith, C.B., K.C., Comptroller-General of the Commercial, Labour and Statistical Departments of the Board of Trade; Mr. James Swinburne, F.R.S., Past-President of the Institution of Electrical Engineers, who

delivered a course of Cantor Lectures before the Society on "Applied Electric Chemistry" in 1896, and also read a paper on "The Nernst Electric Light" in 1899; and Dr. Henry A. Miers, F.R.S., Principal of the University of London, who, as far back as 1896, gave the Society an excellent course of Cantor lectures on "Precious Stones."

None of these gentlemen have served before on the Council in any capacity.

XX.—OBITUARY.

The list of members whose death during the past year the Society has to deplore is much shorter than usual. Several of the deceased members had served in past years on the Council. Earl Spencer, who was elected a member in 1879, became a Vice-President in that year. He was Chairman of the Joint Committee of members of the Royal Commission for the Paris Exhibition of 1878 and the Society of Arts, which organised a series of reports by artisans on the Exhibition. Sir Charles Dilke was a very old member of the Society, for he was elected in 1857 when he was a boy of thirteen. At that time his father and his grandfather were both members, and two years later his younger brother also became a life member. He was on the Council in 1869 and 1870. He read two papers before the Society, and on several occasions presided at its meetings. Another past member of the Council was Mr. H. Graham Harris, who became a member of the Society in 1883, and was elected on the Council in 1896. He served on the Council, with one interval, till 1908, and in 1889 he gave a course of Cantor lectures on "Heat Engines other than Steam." The Society is indebted to Mr. Harris's liberality for the excellent portrait, painted by Mr. Seymour Lucas in 1904, of Sir Frederick Bramwell, Bart., who was his partner.

Others of the members who died during the past year had read papers before the Society, or served on its committees. Sir Charles Elliott read two papers before the Indian Section, one on the Prevention of Famine, and one on the 1901 Census. He was a member of the Indian Section Committee, and a frequent attendant at the meetings of the Section. Sir Caspar Purdon Clarke read papers on "The Domestic Architecture of India," "Street Architecture in India," "Modern Indian Art," and "English Brocades and Figured Silks." Mr. James G. H. Glass read a paper in 1896 on the Land Slip at Gohna. Mr. Thomas Casson read one on Organ Design in 1903, and Mr. George H. M. Batten one on the Opium Question in 1892. Sir Clifton Robinson in 1902 read a paper on Electric Traction. Mr. Alexander Rogers was an old member of the Society, which he joined in 1878, and from 1892 he served on the Committee of the Indian Section. He seldom missed a meeting of the Section, taking part in the discussion on many occasions. Sir Francis Galton joined the Society in 1876, and in 1890 he read before it a paper on "Physical Tests in Competitive Examinations."

Mr. Dorabjee Cama, the head of the Parsi community in London, joined the Society in 1871, but he never took any active part in its proceedings. Sir William Agnew was a member since 1898, and Mr. Alfred Huth since 1883. Mr. Edward Pillow did much excellent work in the cause of technical education in the northern and eastern counties of England, and took part in the discussions at the International Congress on Technical Education in 1897.

The Society suffered the loss during the year of one of its Honorary Corresponding members —Mons. Georges Berger — who was elected when he was General Commissioner for the Paris Exhibition of 1889.

Notices of the above-named, and other members of the Society who died during the past year, will be found in the columns of the *Journal*.

XXI.—FINANCE.

The annual statement of receipts and expenditure was published—in accordance with the usual practice—in the *Journal* last week. It shows the revenue and expenditure for the financial year ending May 31st last, the Assets and Liabilities of the Society, its Investments and the Trusts standing in its name.

The CHAIRMAN (Sir John Cameron Lamb), in moving the adoption of the Report, said as it was the last occasion on which he should have the honour of appearing before them as Chairman of Council, he should like to take the opportunity of very cordially thanking his colleagues for all their kindness and consideration. It would have been quite impossible for him to have done the work without their support and the kindly assistance which they had extended to him on all occasions. The members would see from the Report that during the past session they had had a most excellent series of lectures and papers, and on several occasions additional interest was given to the paper by the presence of very distinguished men in the chair, whose remarks had been most valuable, and had added greatly to the interest of the meeting. The papers had ranged over a very wide field. None of them had been uninteresting, and some were of very high merit

indeed. He said Sir Henry Trueman Wood, the Secretary, had added to their obligations to him by his researches into the early history of the Society. The results of those researches were extremely interesting, and were calculated to increase their pride in so old and honourable a Society. They would have noticed that the membership roll included such men as Earl Howe, Admiral Anson, Admiral Rodney, Lord Clive, Reynolds, Hogarth, Goldsmith, Johnson, Boswell, Gibbon, and William Pitt (Earl of Chatham). He referred to the fact that it had been a record year for honours conferred by his Majesty upon Members of the Council of the Society, and cordially congratulated the recipients. He also thought it was a pleasant coincidence that the Society's Albert medallist for the present year —the Hon. Sir Charles Algernon Parsons—should receive a public honour (the K.C.B.) within two or three days of the announcement of the award, and thought, perhaps, it might be taken as a confirmation, if any were needed, of their choice of so eminent a man for the highest honour that the Society could bestow. The revenue of the Society did not go up by leaps and bounds. Still, their financial position was better than it was last year, which he considered was satisfactory. He regretted that it had not been possible to take any practical steps towards providing better accommodation for the work which the Society carried on there, but he hoped that an early successor in the office of Chairman would have a chance of bringing forward proposals with that object. He could not conclude his words of farewell without calling attention to the invaluable services which the Lord Chief Justice (Lord Alverstone) had so willingly rendered the Society, and asked the members to bear those services gratefully in mind in adopting the Report.

Sir William Henry White, K.C.B., LL.D., Sc.D., F.R.S., seconded the adoption of the Report, which was then agreed to.

The Chairman proposed a cordial vote of thanks to Sir Henry Trueman Wood (the Secretary), Mr. G. K. Menzies (the Assistant Secretary), Mr. S. Digby (the Secretary of the Indian and Colonial Sections), Mr. George Davenport (Chief Clerk), and Mr. J. Buchanan (Accountant), and to the other officers of the Society for their services, and was pleased to think that their able Secretary was supported by such a devoted staff of officers.

Sir Owen Roberts, M.A., D.C.L., LL.D., said it gave him great pleasure to second the resolution, which was carried unanimously.

The Secretary, in returning thanks for this expression of confidence in himself and in the other officers of the Society, acknowledged his indebtedness to Mr. Henry B. Wheatley, the late Assistant Secretary, in the work on which he (Sir Henry Wood) was then engaged in connection with the early history of the Society. Mr. Wheatley had accumulated a great store of knowledge from the old records of the Society from the time of its foundation. He said he had always felt that such a history should be undertaken by one who was familiar with the work of the Society, although he was finding out that their predecessors often did not record the very facts which were most wanted at the present time.

The ballot having remained open for half-an-hour, and the scrutineers having reported, the Chairman declared that the following had been elected to fill the several offices. The names in *italics* are those of members who have not, during the past year, filled the office to which they have been elected.

President.

H.R.H. The Duke of Connaught and Strathearn, K.G.

Vice-Presidents.

*Duke of Abercorn, K.G., C.B.
*The Lord Chief Justice of England, G.C.M.G., F.R.S.
*Sir Steuart Colvin Bayley, G.C.S.I., C.I.E.
Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.
Lord Blyth.
Earl of Cromer, G.C.B., O.M., G.C.M.G., K.C.S.I., C.I.E.
Sir Henry Hardinge Cunynghame, K.C.B.
Hon. Sir Charles W. Fremantle, K.C.B.
Lord Curzon of Kedleston, G.C.S.I., G.C.I.E.
Sir John Cameron Lamb, C.B., C.M.G.
Sir William Lee-Warner, G.C.S.I.
Hon. Richard Clere Parsons, M.A.
Sir Westby B. Perceval, K.C.M.G.
Sir William Henry Preece, K.C.B., F.R.S.
Sir Boverton Redwood, Bt., D.Sc., F.R.S.E.
Sir Owen Roberts, M.A., D.C.L., LL.D.
The Earl of Rosebery, K.G., K.T., D.C.L., F.R.S.
Lord Sanderson, G.C.B.
Alexander Siemens.
Hon. Sir Richard Solomon, G.C.M.G., K.C.B., K.C.V.O., K.C.
Sir William Hood Treacher, K.C.M.G.
Sir William H. White, K.C.B., LL.D., Sc.D., F.R.S.
Sir John Wolfe-Barry, K.C.B., LL.D., F.R.S.

Ordinary Members of Council.

George Ranken Askwith, C.B., K.C.
Henry Taylor Bovey, M.A., LL.D., F.R.S.
Dugald Clerk, F.R.S.
Alan Summerly Cole, C.B.
William Henry Davison, M.A.
Robert Kaye Gray.
Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc.
William Henry Maw, M.Inst.C.E.

* Nominated by H.R.H. the President.

Principal Henry A. Miers, D.Sc., F.R.S.
James Swinburne, F.R.S.
Sir Philip Watts, K.C.B., LL.D., D.Sc., F.R S.
Colonel Sir John Smith Young, C.V.O.

TREASURERS.

Carmichael Thomas.
Professor John Millar Thomson, LL.D., F.R.S.

SECRETARY.

Sir Henry Trueman Wood, M.A.

On the motion of the CHAIRMAN a vote of thanks to the scrutineers was carried unanimously.

Sir STEUART COLVIN BAYLEY, G.C.S.I., C.I.E., proposed a hearty vote of thanks to Sir John Cameron Lamb, not only for presiding on the present occasion, but also for the care he had bestowed on the work of the Council, and for the ability with which he had guided the affairs of the Society during the past year. He was sure that they all regretted his relinquishment of the office of Chairman of Council.

The motion was put to the meeting, and carried unanimously.

The CHAIRMAN acknowledged the vote of thanks.

The meeting then adjourned.

THE ARTIFICIAL SEASONING OF TIMBER.

The amount of timber seasoned by artificial means increases every year, and this is not to be wondered at when it is remembered that wood so treated may be prepared in as many weeks as the natural process takes years. Nor are the results of the artificial process, if carefully managed, inferior in any way to those of the natural operation. Indeed, it is claimed that timber artificially dried absorbs less moisture from the atmosphere than that which is dried naturally.

A great amount of technical skill is required in the management of the drying-kilns. Dry, warm air would crack and twist the green timber. In the early stages of drying, the air must be saturated with moisture, and only dry in the final stages. The arrangement of the most modern kilns is described in the Engineering Supplement of the *Times* :—

"A long closed-in building, capable of holding several thousands of cubic feet of timber, say from 20,000 ft. to 50,000 ft., has a floor laid with rails sloping gently from the end at which the timber is loaded in on trucks to the end opposite, where it is discharged. At one side of the building next the discharging end a fan draws in air over the surfaces of a steam heater, and sends it warmed into that end of the building, whence it traverses along to the loading end, passing in its course between the boards or planks, which are separated about an inch apart by narrow strips of wood laid across at intervals of about two feet. The moisture in the timber is taken up by the warm air first at the discharge end of the kiln, and is deposited again on the timber at the loading end. Thus the saturation of the air increases in its passage from one end to the other, and its volume, intensity of pressure, and temperature diminish also. Entering the kiln as a dry, warm current, it leaves it as a moist, cooled current. The effect on the timber is to remove moisture from the piles at the discharge end and to deposit moisture on those at the entering end; it is taken, therefore, from the timber which is driest and yielded up to the timber that is greenest. In less-pronounced degrees the same process is going on all through the length of the kiln.

"The reason for this practice is as follows:—Green timber, being heavily charged with water and sap, would, if subjected to a warm, dry atmosphere, dry off rapidly on the outside, leaving the interior wet—a condition which is termed case-hardening. The inside would dry in course of time, but it would shrink and crack in doing so, producing the familiar 'shakes.' But if it is saturated with warm air which is heavily laden with moisture, the latter opens the pores right to the centre and prevents them from shrinking, and this is the preliminary stage which is accomplished at the loading end, before any drying-off at all is done. So important is this that in the case of green, hard woods, when they are put into the kiln without any preliminary air-drying, it is usual to subject them to a previous steaming in a separate compartment adjacent to the drying-kiln to ensure thorough saturation. In natural seasoning there is a parallel to this, when balks of timber are floated in running streams for several months with the object of leaching out the sap by the action of water, which water can be easily removed subsequently with less risk of cracking the timber. A similar result is sought when small blocks of hard wood are boiled in water to remove sap and hasten drying.

"In the kiln the trucks of timber are moved forwards at intervals as often as a fresh truck is loaded in, moving towards the discharging end. They are thus brought gradually under the influence of drier air less charged with moisture. The result is that the timber dries from within outwards, with the *minimum* of 'shakes' possible, until, as it arrives at the discharging end, it is subjected only to currents of dry, warm air."

THE PRODUCTION OF HONEY IN CUBA.

The production of honey in western Cuba, as in all other sections of the country, has been an established industry for many years, and is now carried on with more or less vigour, and under conditions which, to some extent, resemble modern methods. The bee, which thrives in Cuba by reason of climate and the abundance of the practically perennial flora, has been developed into a comparatively good stock, the native bees having

been supplanted somewhat by the southern European and American-bred varieties. According to the United States Consul in Habana, this improvement of bee-stock has not been entirely the result of effort in recent years, as the Cubans for generations have imported bees. However, before the advent of the American, bee-keeping in Cuba was in a decidedly primitive state, the hives being makeshift affairs, and very often royal palm-trunks. As the great majority of the honey was sold in strained bulk, and the wax melted down, these crude hives served the purpose in most cases. When the American and other foreign settlers began to come to Cuba, and some of these perceived the opportunity in bee-keeping, modern appliances began to appear, and now the use of the modern hive is well established with both natives and foreigners. There has also ensued better management of apiaries, and as a result there has been an expansion of colonies and a greater production of good honey. Therefore the apiary in Cuba which in the present day has any pretensions towards size and good conditions, may have one hundred to five hundred colonies all housed in good hives, and producing in a season as much as two hundred pounds per colony. The processes of collecting honey in Cuba differ in no essential particular from those in the United States. The hives, as has been stated, are now usually of the American variety, and so also are the various implements employed. The honey is generally brought to the market in strained form, this process being effected at the apiary. The containers are barrels, and the wax is received in moulded form. For strained honey, the average price in the Habana market is from one shilling and eightpence to two shillings a gallon, and the wax from one shilling and threepence to one shilling and eightpence per pound. These prices are a distinct advance on those of two years ago, and therefore have somewhat stimulated the industry. The exportation of honey and beeswax from Cuba now constitutes an important financial item. According to the official statistics for the year 1909, there was exported of honey a total of 9,726,663 pounds, of which the United States is said to have taken 4,140,077 pounds, and Germany 2,773,863 pounds. According to the same statistics, the exports of beeswax amounted to 1,623,353 pounds, of which the United States is said to have taken 697,577 pounds, and Germany 787,788 pounds. Of the total exportation of honey and beeswax the port of Habana has about 75 per cent., this being due largely to the fact that Habana merchants buy the bulk of the production for exportation.

HOME INDUSTRIES.

The Coal Trade.—The strike in one portion of the Welsh coal-field continues, notwithstanding that the Miners' Federation of Great Britain has refused to organise or authorise a national strike of miners. The matter in dispute—namely, the rate of wages payable for working in abnormal places—hardly seems to warrant the loss and misery occasioned by this prolonged industrial conflict. The present position of the coal trade does not suggest that this is a very opportune time for quarrels between masters and men. Coal shipments from Scotland and the north of England have gained by the Welsh disturbance, but even with this assistance the coal exports from Scotland up to the middle of June show a decrease of over 45,000 tons as compared with the corresponding period of last year. Collieries are so short of orders that Lanarkshire coalowners are considering a scheme for the curtailment of output. Prices are said to be unremunerative, and there is little likelihood of their improving, for year by year German competition becomes more formidable. Germany continues to take a considerable quantity of English coal, but the demand is diminishing, and in the markets British superiority is no longer uncontested. Nowadays it is price, not brand, which usually settles the contract. Consumers who used to use Welsh or Newcastle coal, whatever the price, are no longer insistent upon it, owing to the improvement in the methods of consumption. And the consumption of mineral oil as fuel continues to grow. These are factors which warrant some anxiety as to the future of the British coal export trade, but apparently they do not weigh with the Welsh miners on strike.

Synthetic Rubber.—It must be a long time before synthetic rubber seriously affects the price of rubber, but it has to be reckoned with. Dr. Gerlach has been giving his views on it before the Rubber Commission recently appointed by the German Colonial Agricultural Committee, and they are worth noting. In the beginning Dr. Gerlach was sceptical as to its value, and was very much surprised when bulk samples satisfied him that synthetic rubber possesses the essential properties of high-grade material. To what extent the new product will compete with natural rubber remains to be seen. The raw material of synthetic rubber is itself a manufactured article, the production of which, on a large scale, can only be undertaken by a few chemical firms, but there can be little doubt that artificial rubber will eventually appear on the market as a commercial product. Dr. Gerlach thinks that makers will take care that the output is not on a scale sufficient to depress the price of rubber. However that may be, producing costs will have to be largely reduced before serious competition with natural rubber is possible.

Scotch Whisky.—Attempts are being made by some of the larger holders of Highland malt whisky to form a combination, with the object of holding for higher prices. The necessity for some such combination has arisen from the apparent intention of the big blending firms to buy up the stocks. The holders of very old Highland malt whiskies are now few in number, although with

strong financial resources. Having lost heavily over their investments, they naturally want to secure more reasonable prices for the balance of their stocks. The suggestion is that each member of the proposed combination should turn his stocks into it at a certain fixed price and contribute capital in proportion, making up the total to £500,000. The stocks so pooled would be held for a price representing an advance of at least 1s. 6*d.* per gallon on the present range of values. Whether the scheme will come to anything remains to be seen. The proportion of the stocks controlled by the combination, and the extent of the dependence of the big blenders upon the old Highland malt whiskies, must be amongst the determining factors.

Hydrogen Peroxide.—The *Manchester Guardian* has an interesting reference to this bleaching agent, which is manufactured by the action of sulphuric acid on barium superoxide. Barium peroxide always contains traces of iron, manganese, aluminium, and other metallic impurities, derived from the heavy spar from which it is made, and in the process of manufacture these impurities naturally pass over into the hydrogen superoxide. They bring about the rapid decomposition of the peroxide during the concentrating operations, so that their previous removal is necessary; and it is by no means a simple matter. Attempts to work out some other process have proved fruitless until quite recently, though it has long been known that small quantities of the compound are formed when a mixture of hydrogen and oxygen are exploded by means of an electric spark, the principal product of the reaction being, of course, water. This was not considered a very promising field for investigation, but it is now reported that a German chemical firm have overcome the technical difficulties and are producing hydrogen peroxide by a modification of this method. The plant consists of a gas-holder, a number of glass silent discharge tubes through which the gases pass and where they are subjected to the action of the current, a pressure and vacuum arrangement whereby circulation is effected. The gas mixture comes from the holder, goes through the tubes, then passes on through water, which absorbs the peroxide formed, the remaining gases going forward to another holder where the proportions are readjusted. The mixture is brought to the requisite standard and then again treated, so that the process is a continuous one. Alternating current at 8,000 to 10,000 volts is employed. The peroxide is marketed as a 3 per cent. solution —the usual strength. Hydrogen peroxide is used in fairly large quantities for bleaching ivory, bone, and feathers, as well as in the bleaching of textile fabrics and for various other purposes. Its value is due to its action as a powerful but harmless oxidising agent.

The Telephone Transfer.—Last week the Postmaster-General moved a resolution, upon which the Telephone Transfer Bill will be founded, to enable the Government to pay for and take over the telephone system at the end of this year. As the Government and the Company cannot agree upon the value of the system, the matter is to be submitted for decision to the Railway and Canal Commission. It will be remembered that in 1905 the Government agreed to purchase all plant, land, and buildings of the National Telephone Company in use at the date of the agreement, or constructed after that date in accordance with the specifications and rules contained in the agreement, subject to the right of the Postmaster-General to object to take over any plant not suited to his requirements. In the event of disagreement as to price, it was to be fixed by the Railway and Canal Commissioners, as arbitrators, on the basis of the "then value," exclusive of any allowance for the past or future profits, or any compensation for compulsory sale or other considerations. It will be noticed that the agreement follows closely upon the lines laid down by the Tramways Act of 1870, and it can hardly be said to err on the side of liberality. The late Mr. W. E. L. Gaine, the general manager of the Company, stated before a select committee that in the view of the directors the bargain was a hard one, because it gave no consideration in respect of the goodwill of the business, with its gross income of over £2,000,000 per annum, and its net revenue of over £750,000, which the Company had built up. The Company had had to pay for all the experiments and mistakes which are inherent in the launching and developing of any new industry. On the other hand, the Association of Municipal Corporations and the London County Council considered the terms of purchase to be too favourable to the Company.

The Cotton Supply.—The acreage reports show that the area under cotton this season is the largest in the history of the United States, although not as large as was expected by many. The increase is mostly in the extreme south-west. In Oklahama, on account of two bad corn years, the farmers have turned a considerable acreage into cotton. In Louisiana and Mississippi, acreage that had been abandoned on account of its being infested with the weevil has been planted this year, the farmers believing that the rest the soil has had will have had an effect. The size of the crop is more dependent upon the weather and the weevil than upon the acreage planted, and the reports of the condition of the crop are very favourable; but Texas and Oklahama are said to be suffering from heat and want of rain. The acreage reported, 35,004,000 acres, compares well with the revised figures of last year, 33,418,000 acres, which was the largest acreage ever reported up to that date. The trade consider that there is an indication of a possible 14,000,000 bale crop. As for the weevil, it usually does its damage from the middle of July to the end of the season.

Cotton Goods.—It is assumed in some quarters that the relatively lessened consumption of raw cotton means that we are losing our supremacy in

the cotton trade, but many causes have combined to bring about the lessened production of coarse yarns, with a proportionately smaller consumption of the raw material. Better wages and a higher standard of living amongst workers have produced modifications in the goods required by the home trade, and these goods are now manufactured with a lessened quantity of raw cotton for a given yardage. Great changes have taken place in the character of the goods sent out. Heavy "grey domestics" and heavy bleached "Croydons" have almost ceased to be used, being replaced by lighter and smarter goods, requiring less raw cotton to produce. It is the same with the "fustian" trade. Cotton cords, union cords, and moleskins have been replaced by the woollen cloth of Yorkshire, which is at once warmer and smarter. Then again, heavy cotton sailcloth for the use of vessels, for which there was a large demand a generation ago—a material made from heavy coarse yarns—used up much raw cotton, but the demand for sailcloth has now almost disappeared. Similarly the growing use of lamps, gas, and electric light has almost destroyed the need for candlewicks. And there are other heavy cotton goods that have almost ceased to be made.

The Insurance Bill.—It has often been pointed out in these Notes that legislation intended to benefit, among others, the very poor and dependent, has sometimes injured them, and it may be feared that the Insurance Bill, if passed in its present form, will not be an exception to this melancholy tendency. Take Clause 51. It is not to be supposed that it will pass in its present form, but unless amended out of recognition it will make it more difficult for the old and weak to obtain house-room. Given certain conditions, the clause would make it impossible to enforce the payment of rent for twelve months in the case of illness. How would that work? It would make it almost impossible for the aged, or those who appear to be in ill-health, to become tenants. For where is the landlord who is willing to run the risk of having to keep a tenant for a year before he can eject him for non-payment of rent?

NOTES ON BOOKS.

BIRD-FLIGHT AS THE BASIS OF AVIATION. By Otto Lilienthal. Translated from the Second Edition by A. W. Isenthal, A.M.I.E.E., F.R.P.S. London: Longmans, Green & Co. 9*s.* net.

This volume has been compiled from the results of numerous experiments conducted by the brothers Otto and Gustav Lilienthal, and a biographical introduction has been added by the latter, which gives a brief but very interesting account of the man who—if we exclude the very doubtful claims of Icarus—may be regarded as the first martyr to the science of aviation. From early years the attention of the brothers was devoted to studying the flight of birds, especially of the storks which were very numerous in their German home; and as soon as they could scrape together a few thalers they invested them in palisander sticks and willow canes, with which they constructed gliders. So successful were these that from a sandhill fifty metres high Otto finally contrived to make glides up to 350 metres in length.

During the whole course of his life Otto Lilienthal devoted every spare moment to his favourite study, and the more he experimented the more he became convinced that "the only possibility of attaining efficient human flight lies in the exact imitation of bird-flight with regard to the aerodynamic conditions, because this is probably the sole method which permits of free, rapid flight with a minimum of effort." The airmen of to-day have departed far enough from the ideals of Lilienthal, but there are not wanting a few who seem to think that the flying machine of the future may yet revert to something more resembling those ideals than our present aeroplanes. Be that as it may, no student of aviation can fail to be interested in this volume, and in the experiments of one who was certainly an original thinker and a fearless pioneer.

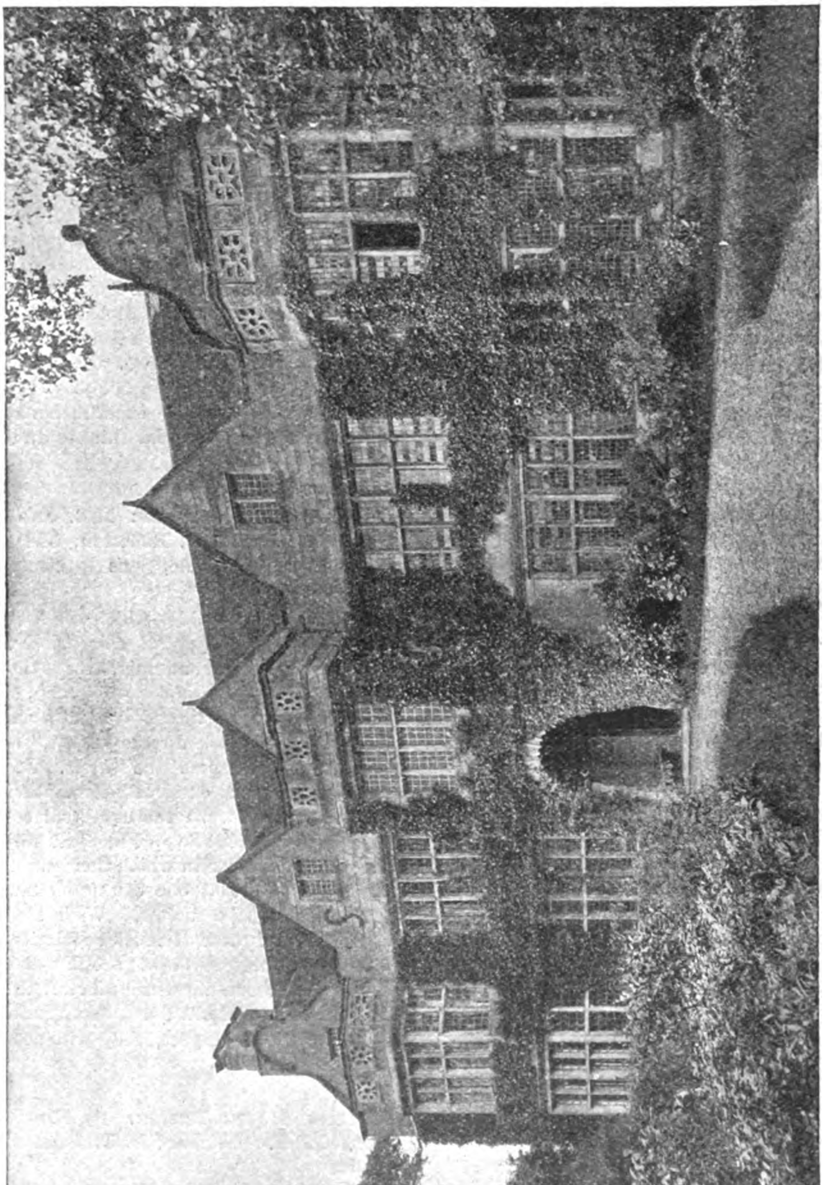
ON WRITING THESES FOR M.B. AND M.D. DEGREES. By H. D. Rolleston, M.D., F.R.C.P. London: John Bale, Sons & Danielsson, Ltd. 1*s.* net.

In this little pamphlet, which was first printed in the *St. George's Hospital Gazette*, Dr. Rolleston gives hints, which one might have hoped would be superfluous for any educated man, on "how to find a subject for a thesis," "what a thesis should be," "how to work up the subject," and how to arrange and compose the thesis. At first sight this strikes one as extremely elementary, and it is only when one recalls the continual complaints of examiners in scientific and medical subjects, as to the deplorable style in which their candidates write their answers, that one can understand the need for reprinting the article. With some brilliant exceptions, however, it must be admitted that the average literary style of the English man of science leaves an immense amount to be desired, and if Dr. Rolleston's words do anything to mend matters in this respect, they will not have been written in vain.

ENGLISH HOUSE DESIGN. By Ernest Willmott, F.R.I.B.A. London: B. T. Batsford. 10*s.* 6*d.* net.

Although a considerable number of books on English domestic architecture have been published in recent years, these are for the most part large, technical and costly, so that there is ample room for a volume like Mr. Willmott's, which contains, in a handy, compendious and inexpensive form, a brief analysis of some of the best specimens of English houses from the sixteenth to the twentieth century. The book is divided into five chapters.

The first deals with the house and its setting, and contains some useful suggestions as to the treatment of the site and its influence upon the design of the house. Chapter II. treats of the chief principles of house design, *e.g.*, proportion, scale, colour, texture, etc. Chapter III.—the longest and most interesting section—is concerned with the old English house, and its gradual development. Chapter IV. discusses in general what Mr. Willmott calls "the Revival," and in particular the work of Philip Webb, Bodley and Garner, and R. Norman Shaw; while Chapter V. contains a considerable and exceedingly encouraging selection from contemporary designs.



ST. JOHN'S, WARWICK.

The author will probably be the last to resent the statement that the chief charm and value of the book lie in the illustrations. There are 150 of these; they have been selected with great taste and care, and they include specimens of every type of house, from the large country seat to the cottage, from the sixteenth century to the present time. The courtesy of the publisher has made it possible to reproduce two of these. The first represents that charming old manor, St. John's, Warwick,

which, one is pleased to notice, has been rescued from the decay which threatened it a few years ago, and restored to its old-time beauty. The name of the architect is unknown, but the house dates probably from the early half of the seventeenth century; with "the regularly ordered projections of the bays, alternating and contrasting with the flat walling between," and the beautiful soft grey colouring of the stone, it forms one of the finest specimens of the manor house in this country, and offers the most pleasurable surprise to one who comes upon it quite unexpectedly in the somewhat prosaic outskirts of Warwick.

The second illustration represents the house, "Orchards," near Godalming. It is the work of Mr. E. L. Lutyens, one of the most original and successful of our present-day domestic architects. Mr. Willmott includes no less than five illustrations of this house—one being a ground plan, two exterior views, and two interior—and no one will think that too much space has been given to this charming building. A good deal of attention is also deservedly devoted to the work of Mr. R. Norman Shaw and Mr. R. S. Lorimer. In connection with the latter it is interesting to notice from the illustration of his manor house at Barton Hartshorn that he appears to be as much at home in work characteristically English as in the Scottish style, with which his name is more generally associated.

" ORCHARDS," NEAR GODALMING.

Mr. Willmott and his publisher have produced a volume which must be eagerly welcomed by all interested in English domestic architecture, and which should certainly be consulted by those who meditate building a country residence, whether a mansion or a cottage.

GENERAL NOTES.

THE PROPORTION OF THE SEXES IN ENGLAND AND WALES.—According to the 1911 Census, the excess of females over males in England and Wales was 1,178,317, the numbers being 18,626,793 and 17,448,476 respectively. In 1801 the proportion of females to males in this area was 1,057 to 1,000; it then declined until 1851, when it stood at 1,042 to 1,000, but for the next fifty years there has been a slight but continuous increase in the proportion. In 1911 it was the same as in 1901, viz., 1,068 to 1,000, but when due allowance is made for the number of males absent in South Africa during the war, there can be no doubt that the true proportion of females to males was somewhat lower ten years ago than it is to-day. There is considerable difference in the sex distribution of the population in different parts of the country. In Monmouthshire the proportion of females to 1,000 males is only 912; in Sussex it is 1,218.

THE RAILWAYS OF THE UNITED KINGDOM.—A return issued by the Board of Trade, giving statistics relative to the railways of the United Kingdom in 1910, shows, amongst other data given, the following:—Length of line open for traffic, 23,387 miles; authorised capital, £1,399,275,000; paid-up capital, £1,318,469,000; passengers carried (exclusive of season-ticket holders), 1,305,633,000; minerals conveyed, 404,825,000 tons; general merchandise, 190,263,000 tons; trains travelled 423,156,000 miles; total gross receipts, £123,889,000; net receipts, £47,297,000; and working expenditure, £76,592,000.

MOTOR-CULTURE IN FRANCE.—Under the auspices of the Association Française de Moto-culture, an important show of agricultural machinery will be held at Melun (Departement Seine-et-Marne) from the 2nd to 9th July next. This show, which promises to be one of the most important of the kind yet held in Europe, will comprise ploughing machinery driven by motors or electricity, haymaking machines, reaping, harvesting and threshing machines, as well as wagons for agricultural puroses worked by motors. There will be a special section for freezing machinery, and machinery for the production of acetylene-gas for farm purposes. Conferences will be held during the week on motor-culture and on other branches of up-to-date rural economy.

THE UNITED STATES SILK INDUSTRY.—According to the American Census returns, the growth of the silk manufactures of the United States has been as follows for the series of years given: 1870, £2,500,000; 1880, £8,300,000; 1890, £17,500,000; 1900, £21,500,000; 1905, £27,000,000; while it is estimated that the returns of production for 1910 will run considerably over £30,000,000. The number of silk establishments has increased from 67 in 1850 to 624 in 1905. In keeping with the increase in the silk establishments, there was a corresponding increase in the imports of the raw material to supply these establishments. For example, the value of the raw silk, which amounted in 1870 to £600,000, rose to £13,700,000 in 1910. In addition to the latter figure, silk waste, to the value of £400,000, was imported, and a considerable quantity of spun silk or schappe yarn.

BEER PRODUCTION AND CONSUMPTION IN GERMANY.—According to the latest statistical reports on the subject, Germany has now lost the first place among beer-producing countries to the United States. In the year 1907 Germany stood easily first, with a production of 1,947 million gallons. In 1909, however, the United States produced 1,873 million gallons, while Germany came second with 1,815 million gallons. The production of the other leading countries in 1909 was as follows: United Kingdom, 1,237 million gallons; Austria-Hungary, 501 million gallons; France, 290 million gallons. Germany exports beer principally to Belgium, the United Kingdom, France, Austria and Switzerland, while it imports from Austria, and small quantities from England. The consumption of beer has steadily decreased since 1900, when it was 31 gallons per caput (in Bavaria 65¼ gallons), while in 1909 the consumption was not quite 26½ gallons per caput (Bavaria 60¾ gallons), so that the consumption per caput in Germany has decreased more than 4½ gallons in the decade.

NATIONAL CONGRESS OF ITALIAN OLIVE GROWERS.—The National Congress of Italian Olive Growers was held last month at Porto-Maurizio (Liguria). The subjects discussed were: 1. The olive and other oil-producing plants; 2. The production and commerce of the table olive; 3. Pruning as a means of regulating the production; 4. Fiscal tariffs in relation to the oil industry; 5. Advantages of co-operation with regard to the cultivation of oleaginous plants and the oil industry; 6. Diseases of the olive-tree and legislation required for their prevention. Many interesting papers were read during the congress, and excursions made in the surrounding district, including one to France to visit the oil-works of the Société du Moulin Co-operative at Levens, where the members were entertained at a banquet. A general opinion appears to prevail, both in France and Italy at the present time, that more drastic measures should be taken by the Governments to prevent the spread of the parasite which infests the olive-tree, and to which the bad harvests of late years may be attributed.

IMPORTS OF WALNUTS TO BOHEMIA.—The Italian consul at Prague reports that the importation of walnuts to Bohemia is considerable. Prague alone receives annually from 1,000 to 2,000 tons, which are sent chiefly from Grenoble. The two kinds, locally known as *markos* and *cornes*—a small, thick-shelled variety—find a ready sale throughout the country, if clean shelled and put up in sacks containing two hundredweight.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE APPLICATIONS OF ELECTRIC HEATING.

By Professor J. A. FLEMING, M.A., D.Sc., F.R.S., M.Inst.E.E.,

Pender Professor of Electrical Engineering in the University of London.

Lecture I.—Delivered March 6th, 1911.

THE LAWS OF ELECTRIC HEATING, RADIATION, AND THERMOMETRY.

The applications of electric heating have become so numerous and important that, although the subject is not entirely novel, there is much of sufficient interest in it to justify its selection as a topic for a course of Cantor Lectures.

Everyone is aware that an electric current creates heat in its conductor. We have the evidence before our eyes in every electric lamp and radiator. Indeed, so common is the knowledge of this fact that when any building takes fire the first instinct of the daily journalist is to ascribe it to the "overheating of the electric wires," although, if the truth were known, the actual cause of the conflagration may have been something quite different. An electric current makes itself evident to us, however, only by the physical effects it produces, and the chief of these are the production of heat in the conductor, of magnetic force around it, and of chemical decomposition in it when it consists of certain liquids. It therefore becomes possible to measure it by the amount of these physical changes it produces, and to express its value in terms of an appropriate unit. We shall not stop to discuss the relative advantages of defining the unit of current thermally, magnetically, or electro-chemically, but simply call to mind the definition of the unit current called the *ampere* as settled and defined by the International Conference on Electric Units and Standards which met in London in October, 1908. It is as follows:—"The ampere is the name for an unvarying unidirectional current of electricity which, when passed through a neutral aqueous solution of nitrate of silver containing fifteen to twenty parts of the dry salt by weight in one hundred parts of water by means of a silver anode and platinum cathode, deposits silver at the rate of 0·00111800 grain per second or 4·0248 grains per hour." This is equivalent to about one ounce in seven hours. This current is a close approximation to one-tenth part of the absolute electro-magnetic unit of current which is defined as the current, unit length of which acts on a unit magnetic pole at a unit of distance with a unit of force (one dyne).

The first question which meets us then is the inquiry as to the amount of heat produced in any conductor by currents of given and various strengths. J. P. Joule proved in 1841, by careful experiments, that for the same conductor the total heat produced by a current varies as the time and as the square of the current. Also the same current passed through various conductors generates heat in them at a rate depending on the dimensions and on the material of the conductor. Taking these conductors in the form of wires or cylinders, the heat produced by unit current varies as the length, inversely as the section, and proportionately to a constant called the specific resistance or resistivity of the material. Combining these statements into a single symbolical one, we have the rule commonly known as Joule's law, which, symbolically expressed, is

$$H = C^2 Rt, = \frac{C^2 \rho l t}{s},$$

H being the heat produced in a time t by the current C in a resistance R, or wire of resistivity ρ, length l, and section s.

It is then necessary to define our units of heat and energy.

The scientific unit of heat is the *calorie*, which is the heat required to raise one gramme of water 1° C. in the neighbourhood of 10° C., or to raise it from 10° C. to 11° C.

The ordinary engineering unit is the British thermal unit (B.Th.U.), which is the heat required to raise one pound of water 1° F. in the neighbourhood of 60° F., or from 60° F. to 61° F. One B.Th.U. is, therefore, nearly equal to 252 calories.

The scientific unit of energy is called one joule, and is ten million times the work done in overcoming a force of one dyne through one centimetre.

The ordinary engineering unit of work is the foot-pound, which is a gravitation unit, and therefore must be specified for a particular locality. Careful experiments by Joule, Rowland, Griffiths, and others, have shown that the amount of heat called the calorie is mechanically equivalent to 4·2 joules, and therefore one B.Th.U. is equivalent to 777 foot-pounds at Manchester, or to 1,058 joules. Lastly, we have a unit of work or energy called one kelvin, or one Board of Trade unit (1 B.T.U.), equal to 3,600,000 joules, or to one kilowatt continued for an hour, or to 1,000 watt-hours. The relations of these various units of heat and energy are exhibited in Table I. below:—

TABLE I.

UNITS OF FORCE, WORK, POWER, AND HEAT, AND THEIR EQUIVALENTS.

1 dyne = the force required to give a mass of 1 gramme a velocity of 1 centimetre per second after acting on it for 1 second.

1 gramme-weight = 981 dynes (at London).

1 erg = work done when a force of 1 dyne is overcome through 1 centimetre.

1 joule = 10 million ergs = 0·7373 foot-pounds.

1 foot-pound = work done when a weight of 1 lb. is lifted 1 foot high against gravity = 1·356 joules.

1 watt = work of 1 joule performed per second.

1 kilowatt = 1,000 watts.

1 kelvin = 1,000 watt-hours = 3·6 million joules.

1 horse-power = 746 watts = 550 foot-pounds per second.

1 calorie = heat required to raise 1 gramme of water 1° C., mechanically equivalent to 4·2 joules or 3·1 foot-pounds.

1 British thermal unit = heat required to raise 1 pound of water 1° F.; mechanically equivalent to 1,058 joules or 780 foot-pounds = 0·294 watt-hour.

1 kelvin = 3,402 B.Th.U. = 857,143 calories.
= 18 pints of water raised from 60° F. to 212° F.

At the outset it is necessary to distinguish carefully between heat and temperature. The temperature of a body is a quality of it in virtue of which it tends to take up or give out heat to other bodies. Two bodies are said to be at the same temperature if, when put in contact with each other, no heat passes from one to the other; and similarly their difference of temperature is a measure of the tendency of heat so to pass. Since addition of heat to a body is, in most cases, associated with a rise in temperature, and with certain other physical effects such as expansion in volume, change in electrical resistance, or change in pressure, we are able to construct instruments called *thermometers*, which enable us to compare temperatures, as well as instruments called *calorimeters*, which enable us to measure quantities of heat.

The ordinary mercury-in-glass thermometer is an appliance by which we test the temperature of a body by means of the visible relative bulk expansion of mercury in glass, as shown by the rise and fall of the mercury in the stem.

There are certain physical changes, such as the melting and boiling-points of various bodies, which always take place at identically the same temperatures, and hence give us what are called *fixed points* of temperature. To obtain a scale of temperature we have to assume certain numerical values for two of these temperatures, and divide the interval in an arbitrary manner. Thus, if we take 0 to represent the melting-point of ice, and 100 that of the steam of water boiling under 760 mm. barometric pressure, and divide the interval into 100 degrees, we obtain the Centigrade scale, which is continued below 0° C. and above 100° C. with equal intervals.

This mode of constructing a temperature scale is perfectly arbitrary. Two mercury-in-glass thermometers made with different qualities of glass and agreeing in temperature reading at the fixed points will not necessarily agree in their readings at intermediate points, owing to the differences in the law of expansion of the two glasses. A better scale is obtained by employing the change in pressure of a constant volume of one of the gases with very low boiling-point, such as hydrogen or nitrogen. A given volume of these gases increases in pressure between 0° C. and 100° in very nearly the ratio of 273:373. Hence a degree of temperature may be defined as the increment of temperature which increases the pressure of a unit of volume of hydrogen or nitrogen by an amount equal to $\frac{1}{273}$ of its pressure at 0° C.

If the gas followed the same law of pressure-variation without change of state as the temperature continually decreases, it is obvious that the

pressure would vanish entirely at 273 degrees below the melting-point of ice. This temperature is therefore called the absolute zero on the constant-volume gas thermometer, and temperatures reckoned from this point are called absolute temperatures. The slight variations in the coefficients of expansion of different gases, and of the vessels in which they are contained, makes this gas scale also an arbitrary one, so that temperatures have to be defined by reference to some standard air thermometer such as the constant-volume nitrogen thermometer, which is the standard of reference at the International Bureau of Weights and Measures at Sèvres, near Paris. Lord Kelvin suggested, however, in 1848, in the *Philosophical Magazine*, a method of defining temperature without reference to any particular substance, which is based on thermodynamic considerations, and at the same time showed that there must be an absolute zero of temperature which was found to coincide closely with the absolute zero as defined by the constant-volume gas thermometer.

Experiment proves that whilst we can convert the whole of any quantity of mechanical work into heat, as, for instance, when a train is stopped by its brakes, we cannot in general convert the whole of any quantity of heat into mechanical work. We can only convert part of it, whilst at the same time some other part must be lowered in temperature. Thus an engine takes steam from a boiler at a high temperature. The steam, after use in the engine, is given up to the air or to the condenser at a lower temperature, and part of the heat originally in it disappears as heat, but the equivalent energy is obtained as mechanical work done by the engine. If the engine is a reversible one—that is, can not only be used to convert heat into work, but work into heat—then its efficiency of conversion for heat into work is easily shown to be a maximum, and to depend only upon the temperature of the source of heat and upon that of the condenser or sink. Lord Kelvin proposed to define the temperature of the source and sink or furnace and condenser by the following statement:—As the heat taken from the source is to the heat given up to the condenser, so is the temperature of the source to the temperature of the condenser. It is obvious that this mode of defining temperature necessitates an absolute zero, because less than no heat cannot be given to the condenser. Lord Kelvin and Mr. Joule found, by experiments on the change of temperature of gases when forced through porous plugs, that a comparison could be made between the thermodynamic scale and the ordinary gas thermometer scale. The results proved that when using air, nitrogen, or hydrogen gases, the thermodynamic scales and the gas thermometer scales were not sensibly different. Hence we arrive at the conclusion that there is an absolute zero of temperature, and that it is close to $-273°$ on the Centigrade scale, and also that the scale of temperature defined by the constant-volume nitrogen or hydrogen thermometer is closely in accordance with the absolute thermodynamic scale. When, therefore, we speak of absolute temperatures it is understood to mean temperatures reckoned on that scale on which the melting-point of ice is 273° and the boiling-point of water under normal pressure is 373°.

We can now specify more exactly the relation of heat and temperature. If a quantity of heat is imparted to a body not sufficient to change its phase or state from solid to liquid or liquid to gas, it will raise its temperature by an amount such that the rise in temperature in degrees is equal to the quotient of the heat given in calories by the mass of the body in grammes, and by a coefficient called the specific heat at that temperature, or, symbolically

$$T = \frac{H}{MS},$$

where T is rise in temperature, H is quantity of heat, M is mass, and S is specific heat. If heat can escape from the body by radiation, conduction, or convection, then the total heat imparted to it must supply the loss as well as the rise in temperature. If, therefore, we can prevent heat from escaping from a body, a very small rate of production of heat in it will, if continued for long, raise the temperature to a very high degree.

In general, when conducting metallurgical or other chemical operations, we require a mass of matter to attain a certain temperature, and that often as quickly as possible. We can best achieve this by insulating the body for heat as completely as possible, and creating the heat inside it electrically. There are, however, some paradoxes in connection with this matter. If, for instance, we pass an electric current through a wire and generate heat in it at a certain rate, the temperature will gradually rise until a point is reached at which the loss of heat by radiation and convection, which increases with the temperature, just balances the heat gain, and the temperature then remains stationary. If part of a platinum wire is closely covered with glass melted on to it, it might be supposed that this,

by keeping in the heat, would cause that covered part to rise to a higher temperature than the rest. As a matter of fact, as first noticed by Professor A. W. Porter, it keeps that part cooler. The reason is that the glass becomes a thermal conductor when hot, and as the covered portion offers a larger surface for the escape of heat than the bare part, the coated part never attains so high a temperature as the uncoated part.

As a rule, however, covering a conductor with asbestos, or other non-inflammable heat insulator, causes it to come to a higher final temperature when a given steady current is passed through it.

Assuming, however, that the body is brought to a high temperature and allowed to lose heat by radiation, an important question is the relation between the temperature and the energy sent out as radiant heat per square unit of surface. Professor J. Stefan suggested, in 1879, and Professor Boltzmann, in 1884, showed theoretically, that the relation between temperature and radiated energy is as follows:—The energy (E) radiated as heat from every square unit of surface of a black body is proportional to the fourth power of the absolute temperature of that surface, or

$$E = KT^4,$$

where K is some constant. As, however, the radiating body is always in some enclosure at a temperature T_0 the law is better specified by the formula

$$E = K\,(T^4 - T_0^4).$$

It will be noticed that the above law is specified for a "black body," and it is necessary to explain what this means. A perfectly black body is one which absorbs all rays falling upon it and reflects and transmits none. No actual surface is perfectly black at all angles of incidence, not even lampblack, which is the nearest approach. A perfectly black area may, however, be realised by making a small hole in a large hollow metal ball. If rays fall on the hole they enter and are scattered about by reflection in the interior, but few or none emerge again. Hence the area of the hole as viewed from outside is a black body. In consequence of the universal law of radiation that good absorbers are good radiators, it follows that a lampblack surface radiates at any temperature the maximum energy possible. For if there were any surface which could radiate more than a black surface, it would, *ipso facto*, absorb better, but that is impossible, because by hypothesis it absorbs all the rays which fall upon it. Hence the black body is the body which has the maximum radiation at a given temperature. Accordingly we can obtain a perfectly black radiator by making a small hole in a metal or other hollow sphere, and then heating this ball to the required temperature. The radiation which comes out of the hole will be black-body radiation. The material of which the ball is made is of no consequence. For the radiation which proceeds from the hole is not merely the radiation emitted from the interior parts visible through the hole, but is supplemented by radiation from all other portions reflected from those visible parts. Now, the reflecting power of an opaque body is the complement of its absorbing power, and therefore of its radiating power. Hence, even if the interior of the ball were coated with a white substance, the increased reflecting power would just compensate for the decreased radiating power, and the radiation escaping from the hole would be substantially the same as if the interior were coated with lampblack. Practically we can construct a radiator which is in effect a black body, by inserting into a furnace a metal or porcelain tube closed at the bottom (see Fig. 1). This tube

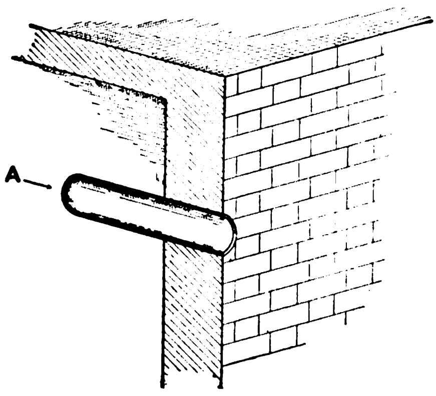

FIG. 1.—A CLOSED TUBE BUILT INTO A FURNACE TO FORM AN IDEAL "BLACK-BODY" RADIATOR.

becomes red-hot, and the radiation proceeding from the open end of the tube is substantially black-body radiation. The Stefan-Boltzmann law can thus be applied by means of instruments called radiation pyrometers—to be described presently—to the determination of furnace temperatures, and that of other radiant bodies, including even the sun. Another important law of radiation is that enunciated by Professor W. Wien in 1879, known as the Wien displacement law. If we expand the radiation from any hot body, by means of suitable diathermous prisms or a diffraction grating, into a spectrum, and measure by means of the bolometer the

energy contained in successive narrow slices of the spectrum, and represent these radiated energies

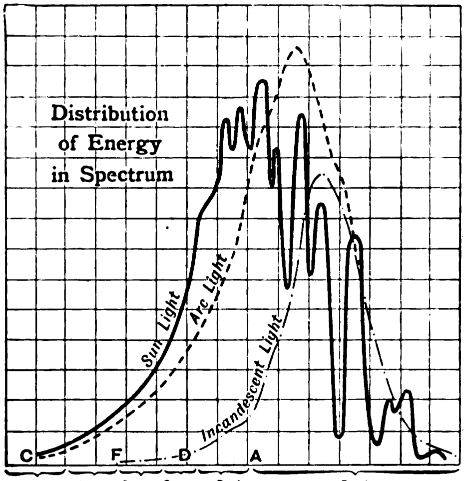

FIG. 2.—CURVES REPRESENTING BY THE HEIGHT OF THEIR ORDINATES THE ENERGY DISTRIBUTION IN THE SPECTRUM OF VARIOUS ILLUMINANTS.

as ordinates in terms of the corresponding mean wave length, we obtain a curve called an energy curve, which for most artificial sources of light has a maximum value, somewhere in the spectrum, mostly beyond the red or in the ultra-red part of the spectrum (see Fig. 2). Let the wave length corresponding to the

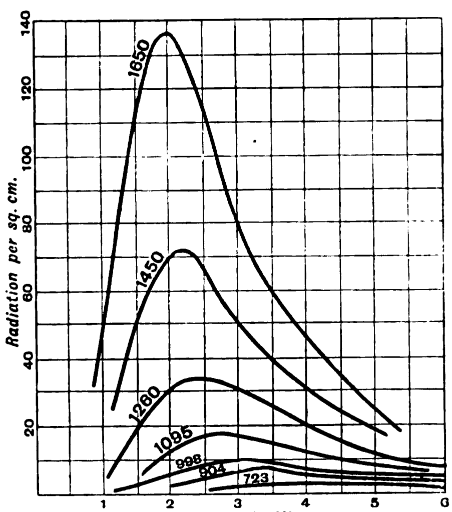

FIG. 3.—CURVES REPRESENTING THE RADIATION PER SQ. CM. FOR A "BLACK BODY" CORRESPONDING TO VARIOUS WAVE LENGTHS (MEASURED HORIZONTALLY) AND FOR VARIOUS ABSOLUTE TEMPERATURES AS MARKED ON THE CURVES.

portion of maximum energy be denoted by λ_m, and let the surface absolute temperature of the radiant body be T. Then Wien's law is, that the product $\lambda_m T$ is constant. Hence, in proportion as the absolute temperature rises, the wave length of the rays of maximum energy falls or is displaced towards the violet end of the spectrum.

The curves in Fig. 3—taken from a paper by Lummer and Pringsheim in the *Annalen der Physik und Chemie*, Vol. 63, p. 395, 1897—delineate these energy curves for a black body at various absolute temperatures marked on them. The abscissæ are wave lengths in microns (μ), or thousandths of a millimetre, and the ordinates are proportional to the intensity of the radiation.

In this case the product of $\lambda_m T$ is, on an average, equal to 2,940. Wien also showed that the energy radiated by a narrow slice of the spectrum at the point of maximum energy varied as the fifth power of the temperature of the radiant body, or $E_m \cdot T^{-5}$ is a constant quantity.

Wien's two laws, and also the Stefan-Boltzmann law, have received full experimental confirmation within certain limits. Wien's first law holds good even for bodies which are not black, but then the constant value of $\lambda_m T$ is less than that for a black body.

Wien has also shown how to obtain theoretically an expression for the energy E emitted per unit of surface by a black body at an absolute temperature T at various wave lengths λ. His result is as follows—

$$E = A\lambda^{-5} \epsilon^{-B/\lambda T},$$

where A and B are constants. The above expression is, in fact, the equation for the energy curve of the spectrum of the black body. Planck has modified Wien's formula into the form

$$E = A\lambda^{-5} \left(\epsilon^{B/\lambda T} - 1 \right)^{-1},$$

which is slightly more accurate, or agrees better with experimental results. It is obvious that the above expressions for E are functions of λ and T which have small values both when λ is very small and when it is very large, assuming T constant. Also it is easy to prove by differentiating the expression for E with regard to λ that it has a maximum value corresponding to a certain value of λ, and we can thus deduce both of Wien's laws, viz., that $\lambda_m T$ is constant and hence that the product $E_m T^{-5}$ is also constant, from the above expressions for E.

In Fig. 4 are shown a set of such radiation curves plotted by Dr. Drysdale from Wien's formula, giving the values A = 41400 and B = 14700 to the constants. The value of the constant in Stefan's law has also been experimentally determined. One of the latest measurements is by E. Bauer and M. Moulin (see *Journal de Physique*, 1910, Vol. XI., p. 468). They obtain the value $5 \cdot 3 \times 10^{-12}$, which is the factor by which the fourth power of the absolute temperature of the surface must be multiplied to give the radiation in watts

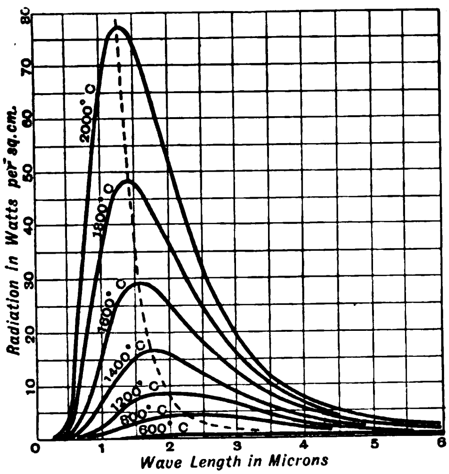

FIG. 4.—RADIATION CURVES PLOTTED BY DR. DRYSDALE FROM THE EQUATION $E = 41400\lambda^{-5}\epsilon^{-14700/\lambda T}$.

per square centimetre of surface. In any case, therefore, in which we can determine the radiation in watts per square centimetre of a radiating body, we can determine the surface absolute temperature, provided the radiant body is substantially a black body. For instance, in the case of a 14 c.p. carbon-filament glow-lamp radiating 50 watts, the carbon surface was found to be nearly one square centimetre. Hence, using the above constant in Stefan's law, the absolute temperature of the filament should be

$$T = \sqrt[4]{\frac{50 \times 10^{12}}{5 \cdot 3}} = 1760^\circ \text{ abs.} = 1487^\circ \text{ C.},$$

and this is known to be not far from the temperature of a carbon filament working at 3·5 to 4 watts per c.p.

Determinations of the solar radiation by various means have shown that the sun's photosphere radiates at the rate of 10,000 watts per square centimetre. Hence the absolute temperature should be

$$T = \sqrt[4]{\frac{10000 \times 10^{12}}{5 \cdot 3}} = \frac{10000}{\sqrt[4]{5 \cdot 3}} = 6660^\circ \text{ abs.}$$
$$= 6400^\circ \text{ C.}$$

Numerous measurements have shown that the solar photosphere on its outer portions has a temperature between 6,000° C. and 7,000° C.

Again, observations on the area of the crater on the positive carbon of an electric arc, combined with a measurement of the power expended on it, show that for a 10-ampere arc the radiation from the crater is at the rate of 25 or 30 watts per square millimetre or 2,500 to 3,000 watts per square centimetre. Hence the absolute temperature of the arc crater should be

$$\sqrt[4]{\frac{2500 \times 10^{12}}{5 \cdot 3}} = 4600^\circ \text{ abs.}$$

This is equivalent to 4,327° C. This value is rather higher than that obtained experimentally, but the difficulty of measuring the area of the arc crater accounts fully for the difference. Nevertheless, the temperature is of the right order. In the same manner Wien's first law can be employed to determine the temperature of an approximately black body whenever the wave length of the ray of maximum energy can be determined. For instance, Lummer and Pringsheim determined in this manner values for the temperature of various radiators as below

Source of Radiation.	Wave lengths in microns of ray of maximum energy emitted, $= \lambda_m$.	Absolute Temperature deduced by Wien's formula $T = 2940/\lambda_m$.
The Sun . .	$0 \cdot 55 \times 10^{-3}$ mm.	5300° abs.
Electric Arc .	0·7 " "	4200° "
Nernst Lamp .	1·2 " "	2450° "
Welsbach Burner . .	1·2 " "	2450° "
Carbon filament Glow Lamp .	1·4 " "	2100° "
Candle . . .	1·5 " "	1960° "
Argand Gas Burner . .	1·55 " "	1900° "

The value of λ_m for the sun is uncorrected for atmospheric absorption, which is known to reduce the apparent temperature of the sun. This absorption cuts off at least 20 per cent. of the solar radiation. Hence we must increase the value (5,300°) by one-fifth and we have 6,400° abs., a value quite close to that obtained by the application of Stefan's law.

It is interesting to note that the wave length of light for which the eye is most sensitive is in the yellow-green, which is in the neighbourhood

of that wave length $0 \cdot 55\mu$, which has the maximum energy.

It should be added that in making this measurement of the wave length of solar light conveying the maximum energy, the diffraction or normal spectrum must be employed and the energy estimated by the bolometer.

We can now pass on to consider the more accurate measurement of temperature by electrical methods, as a preliminary to discussing the technical applications of heat produced electrically.

There are three methods of temperature measurement based on electrical phenomena which have been brought to a state of great perfection, and provide the means of conducting and controlling operations in the arts and manufactures far exceeding in accuracy any of the older methods of thermometry depending upon the expansion of solids, liquids, or gases. These methods of temperature measurement are as follows:—(1) By electrical resistance thermometers; (2) by thermo-electric pyrometers; (3) by radiation or optical pyrometers.

The first method is based on the well-known fact that the electrical resistance of pure metals increases with the temperature. In conjunction with Sir James Dewar, the writer made an extensive investigation of the variations of resistance of extremely pure metals between temperatures of $+200°$ C. and $-200°$ C., and depicted the result in a chart. It was found that these lines slope downwards at various angles, but so as to indicate that in the neighbourhood of the absolute zero the electrical resistance of pure metals would be vanishingly small. As far back as 1871 Sir W. Siemens had proposed to use the variation of resistance of pure platinum as a means of temperature measurements, but in consequence of variations in the resistance, caused by the manner in which he supported the wire by winding it on a porcelain rod, the first attempts were not very encouraging.

It was not until 1887 that the careful researches of Callendar re-established the value of this method of temperature measurement. Callendar employed a fine wire of pure annealed platinum so supported by being wound loosely on a mica frame that it was not in contact with clay at a high temperature. Platinum placed in contact with clay or porcelain at very high temperatures becomes contaminated with impurities which change its electrical qualities. This fine wire is welded to two other thicker platinum wire *leads*, and a pair of the same thick wires of equal length, but joined directly together at the bottom, are used as "compensating leads," and placed in contiguity to the actual leads. If, therefore, we measure on a Wheatstone's bridge

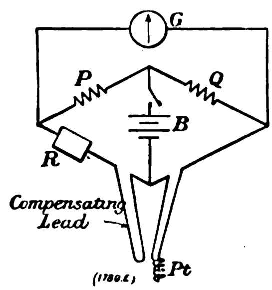

FIG. 5.—WHEATSTONE'S BRIDGE ARRANGEMENT OF CIRCUITS FOR MEASURING PLATINUM THERMOMETER RESISTANCE.

(see Fig. 5), or by a differential galvanometer, or in any other way, the difference of the resistance of these two circuits, this difference is equal to the resistance of the fine platinum wire. This wire may then be placed in any region the temperature of which it is desired to know. If R_t is the resistance of the wire at $t°$ C. and R^0 is its resistance at 0° C., then it is found that

$$\frac{R_t}{R_0} = 1 + \alpha t + \beta t^2,$$

where α and β are called temperature coefficients. The above is the equation for a parabola, and hence the resistance is said to be a parabolic function of the temperature. The coefficient β is generally small, and for platinum α is a quantity near $0 \cdot 00365$. Between 0° and 100° the resistance curve is nearly a straight line. Let R be the resistance of the wire measured at any temperature $t°$ C. Callendar introduced a new way of measuring temperature according to a scale called the *platinum temperature* (*pt*) *scale*, as follows:—The increment of resistance of platinum is proportional to the increment of platinum temperature. Hence, if R, R_0 and R_{100} are resistances at (*pt*) 0° C. and 100° C. respectively, we have

$$pt = \frac{R - R_0}{R_{100} - R_0} .100.$$

Callendar showed that the relation of the platinum temperature to the air thermometer temperature (t) could be expressed by the formula

$$t - pt = \delta \left(\frac{t}{100} - 1\right)\left(\frac{t}{100}\right).$$

The quantity δ is called the *principal constant* of the thermometer, and is related to the temperature coefficients α and β as follows

$$\alpha = c\left(1 + \frac{\delta}{100}\right), \ \beta = - c\delta/10000.$$

Hence, if we measure the platinum temperature by the resistance of the wire, we can at once convert the reading into air-thermometer temperature.

platinum wire at 0° C. This is easily done by a rheostat A and switch S, as shown in Fig. 8.

Many instrument-makers now furnish direct-reading platinum resistance thermometers, made

FIG. 6.—PLATINUM RESISTANCE THERMOMETER IN A QUARTZ TUBE. (Messrs. J. J. Griffin & Sons.)

on one or other plan, and in some cases the platinum wire is protected by insertion into a steel tube when it is to be used to determine furnace temperatures. In all cases the compensating leads must be run down the same tube as the leads connected by the platinum thermometer wire, so that all parts of them may be at the same temperature and vary in the same way as the actual leads. This obviates any correction for lead resistance. The resistance of the

Another formula for doing this directly is that due to Mr. J. Hamilton Dickson, who showed that if R is the resistance of a platinum wire in ohms at t° C., then

$$(R+a)^2=p\ (t+b),$$

where a and b are constants.

In carrying into effect practically this method of measuring temperature the platinum wire has to be supported and protected so that it can be placed in any region of temperature between absolute zero and 1,200° C. and at the same time take up quickly the temperature of the region. This may be done by winding the platinum wire on a quartz rod, over which is placed a quartz tube, and the two are melted together so that the turns of platinum wire are embedded, kept in place, and protected by an infusible covering not easily acted on by heat or chemical agents. Such a platinum resistance thermometer is here exhibited, kindly lent me by Messrs. J. J. Griffin & Sons (see Fig. 6). The resistance wire and its leads and the compensating leads are then connected into a Wheatstone's bridge, as shown in Fig. 5. We may then balance the bridge in the ordinary way by adjusting the resistance of the arms so that the galvanometer G shows no current in the bridge, and determine the resistance R of the thermometer T by the ordinary bridge formula; and hence the platinum temperature pt by the formula already given. On the other hand, the increase in resistance of the thermometer wire when heated may be allowed to create a current in the galvanometer circuit, and the galvanometer scale may be calibrated so as to indicate by the galvanometer needle deflection Centigrade temperature of the wire directly, as in the instrument shown in Fig. 7, which is supplied by Messrs. Griffin & Sons.

In this case we have to provide some means for regulating the battery current so that the galvanometer always reads zero when in place of the platinum thermometer we substitute a constant resistance R_4 equal to that of the

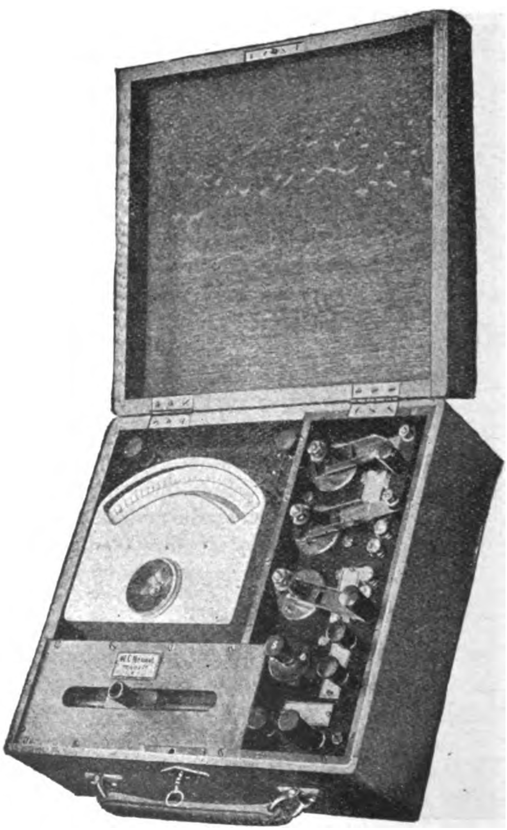

FIG. 7.—DIRECT-READING COMBINED BRIDGE AND GALVANOMETER FOR TAKING PLATINUM TEMPERATURES WITH THE QUARTZ THERMOMETER. (Messrs. J. J. Griffin & Sons.)

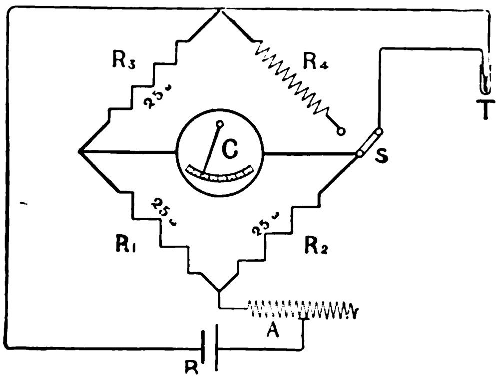

FIG. 8.—SCHEME OF CONNECTIONS OF THE DIRECT-READING WHEATSTONE'S BRIDGE AND PLATINUM THERMOMETER SHOWN IN FIG. 7.

platinum thermometer wire may be five or ten ohms, and a resistance is provided exactly equal to the resistance of that wire at 0° C.

In the direct-reading forms of bridge, where the deflection of the galvanometer gives the reading at once, the operation of taking a temperature with the platinum resistance thermometer is just as speedy as taking it with a mercurial thermometer, but is a great deal more accurate. Moreover, the actual thermometer wire need not be near the bridge, and several platinum thermometers can be adjusted to be read by one bridge with the aid of a switch. Hence, the temperature in distant parts of a building, in chimneys, flues, inaccessible parts of steam-boilers, vats or heaters, can be taken in an office or laboratory without moving the reading instrument (see Fig. 9). In these cases the platinum thermometer wire should have a rather high resistance, and the connecting leads resistances not exceeding one ohm. Moreover, by recording instruments it is quite easy to obtain a curve on paper showing the continuous variation of the temperature of any region far or near.

There are, therefore, several different methods by which the temperature of a region can be ascertained by means of the platinum thermometer. For scientific purposes, where speed is not an object, we may determine the resistance of the platinum wire by the ordinary Wheatstone's bridge measurements made with great care. The particular thermometer used must then have its principal constant δ determined by measuring its resistance at three fixed temperatures. The most convenient are the melting-point of ice (0° C.), the temperature of the steam of water boiling under 760 mm. pressure (100° C.), and the boiling-point of sulphur under the same pressure (444°·55). Having obtained the value of δ, which varies slightly from wire to wire, we can obtain the Centigrade temperature ($t°$) corresponding to any platinum resistance (pt) from the formula

$$t - pt = \delta\left[\left(\frac{t}{100}\right)^2 - \frac{t}{100}\right].$$

The value of δ for pure platinum is nearly 1·5.

Tables have been published (see "Technical Thermometry," by the Cambridge Scientific Instrument Company, Ltd.) giving the value of the air thermometer temperature for various platinum temperatures from 0° to 1,100° C.,

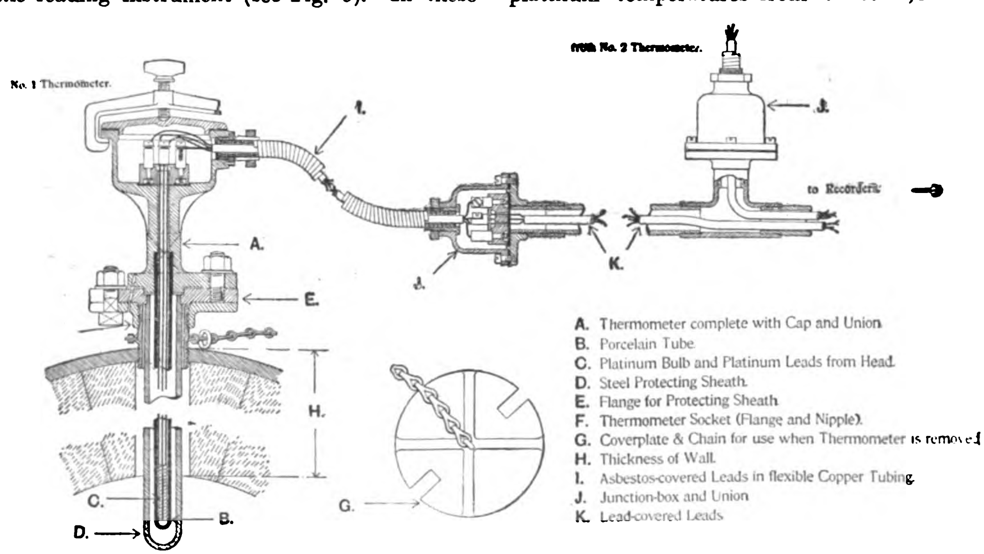

FIG. 9.—PLATINUM RESISTANCE THERMOMETER PLACED IN A HOT-AIR MAIN TO RECORD TEMPERATURES BY WHIPPLE OR CALLENDAR RECORDER.

which greatly facilitate the use of the resistance thermometer. The two scales agree at 0° C. and 100° C, but at 1,000° C. the corresponding platinum temperature is 865° *pt*. Thus above 100° C. the platinum temperature is always numerically less than the air scale temperature.

For industrial purposes the adjustment of the bridge resistance may be made to show directly on some scale the temperature at the instant when the galvanometer needle is at zero and the bridge balanced. This is done in the Whipple Temperature Indicator, as constructed by the Cambridge Scientific Instrument Company (see Fig. 10), where the battery, galvanometer, and bridge are all contained in one box and the resistance thermometer placed at a distance in some locality where the temperature has to be determined, but connected with the bridge by suitable leads. Or else a Callendar recorder, by the same instrument makers, may be used (see Fig. 11). This is an arrangement in which the deflection, one way or the other, of the coil of a movable-coil galvanometer, which is placed in the bridge circuit, closes another circuit and causes a motor to move a pen along a sheet of paper in such manner that when the temperature rises, the pen moves one way, and when it falls, the pen moves the other way. The pen therefore traces a continuous record on the paper, showing the variations of resistance of the platinum wire corresponding to the variation in the temperature of the locality in which it is placed (see Fig. 12).

In place of a Wheatstone's bridge, some type of ohmmeter may be used to measure the resistance of the platinum wire at various temperatures. In the Harris direct-reading resistance thermometer a differential ohmmeter is employed which measures and shows by the deflection of a needle on a scale the difference in the resistance of a platinum resistance thermometer and that of the compensating leads. This instrument is made by Mr. R. W. Paul, and is certainly one of the most convenient forms of direct-reading thermometers.

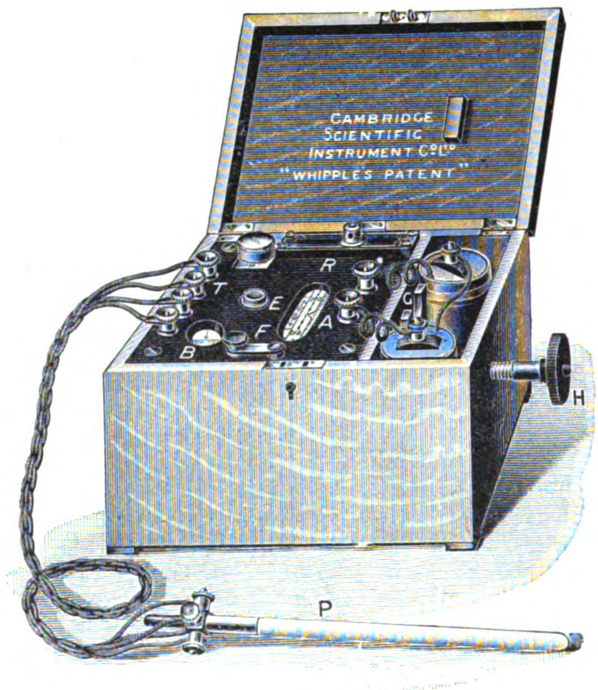

FIG. 10.—WHIPPLE TEMPERATURE INDICATOR AND PLATINUM RESISTANCE THERMOMETER P, AS MADE BY THE CAMBRIDGE SCIENTIFIC INSTRUMENT COMPANY.

A few important industries in which such platinum thermometry is now employed to record or control temperatures are as follows:—In hardening steel tools a variation of even a few degrees in the temperature to which the metal is raised makes a difference in the result. A great authority, Mr. Brayshaw, says that a variation of 5° C. makes all the difference between good and bad hardening. In brick and

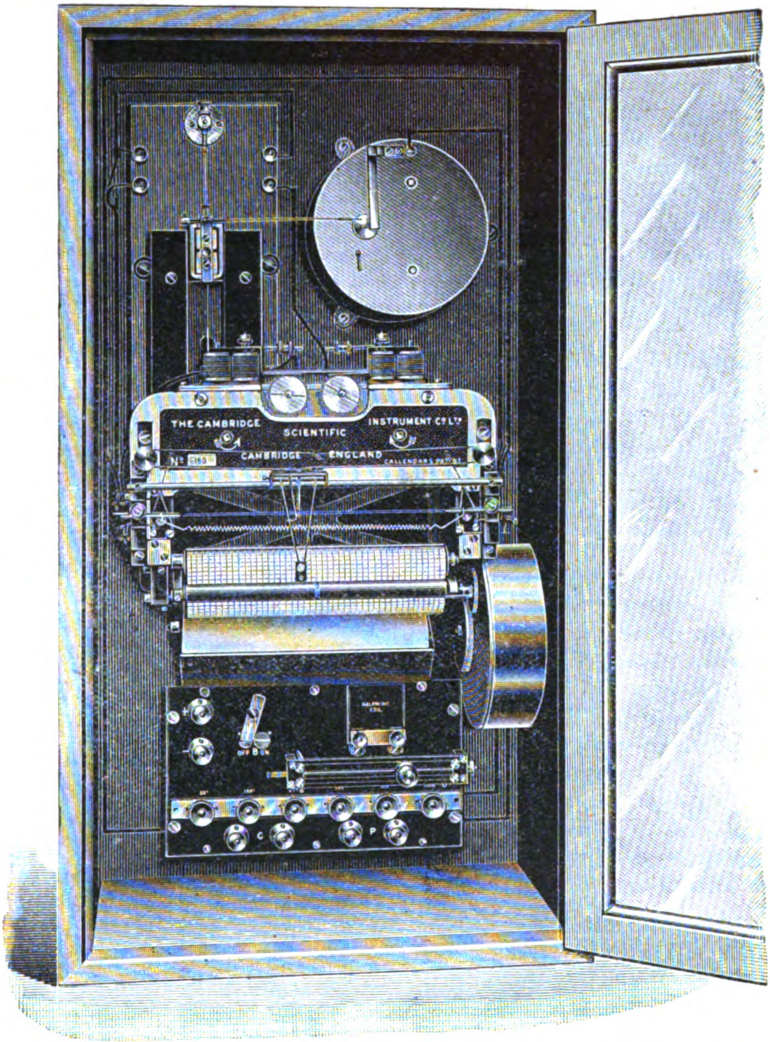

FIG. 11.—CALLENDAR RECORDER FOR RECORDING GRAPHICALLY VARIATION IN TEMPERATURE.

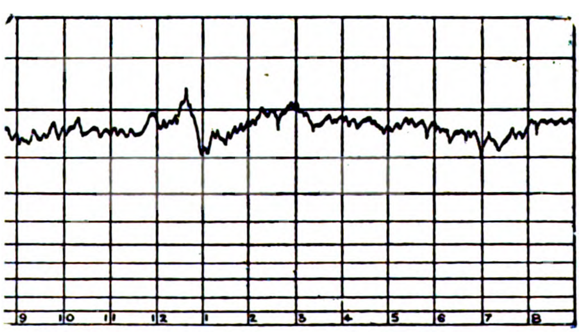

FIG 12.—A GRAPHIC RECORD OF TEMPERATURE VARIATION AS MADE BY A CALLENDAR RECORDER.

porcelain kilns a knowledge of the temperature is most important. In breweries, cold storage, blast furnaces, superheaters, steel annealing, jam boiling, and innumerable other arts, the success of the operation depends entirely on the temperature not falling below or rising above certain limits. A platinum resistance thermometer provides the simplest and most accurate means for determining and recording the temperature from moment to moment, even when the measurement has to be made at a point not very near the place at which it is recorded.

A second method of temperature measurement is based on the facts of thermo-electricity. If a circuit is formed of two wires of different materials, and if the junctions are kept at different temperatures, there is in general an electromotive force in the circuit called a thermo-electromotive force. For every pair of

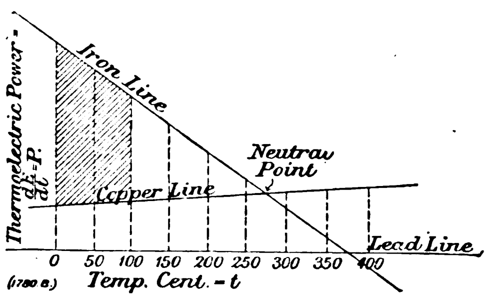

FIG. 13.—THERMO-ELECTRIC LINES OF IRON AND COPPER IN A THERMO-ELECTRIC DIAGRAM.

metals there is, however, a certain temperature called the neutral temperature, at which the metals are thermo-electrically identical, so that if the temperature of one junction is as far above the neutral temperature as the other is below it, there is no current in the circuit.

Speaking generally, however, there is one source of electromotive force at the junction of two metals which is a function of the temperature, and is called the Peltier effect. Hence, generally in a thermo-couple the E.M.F. is partly due to unequal Peltier effects at the two junctions. But there is also a second source of E.M.F. called the Thomson effect, which is due to the fact that portions of the same metal at different temperatures are thermo-electrically different. Hence, when there is a gradient of temperature down a metal wire, there is also a source of electromotive force in it.

The facts of thermo-electricity are best represented by a thermo-electric diagram having drawn on it the so-called thermo-electric lines. For each metal we can draw on it a line approximately straight such that if abscissæ represent temperature the ordinates represent thermo-electric power, $P = d\,E/dt$ (see Fig. 13). The line representing *lead* is taken horizontal and as the datum line. If a couple be made of the given metal and lead, and if the junctions are kept at temperatures t and $t + dt$, where dt is a small difference, then the thermo-electric power of the given metal at the temperature t is defined to be the rate at which the E.M.F. in the metal-lead couple circuit is changing at that temperature. Hence

$$P = \frac{dE}{dt} \text{ or } E = \int P\,dt.$$

If two ordinates are drawn corresponding to two temperatures, T_1 and T_2, then the area included between these ordinates and the thermo-electric line of the metal and the base line of lead represents to scale the E.M.F. in the circuit. If, therefore, we draw the thermo-electric lines of two metals, A and B, and form a couple of them with junctions at temperatures T_1 and T_2, then the area included between the two thermo-electric lines and the two ordinates represents to scale the E.M.F. in that circuit. For our present purpose it will not be necessary to enter into a discussion of the facts of thermo-electricity further than to say that with the exception of iron and bismuth the thermo-electric lines of most metals are nearly straight lines, and this indicates that the thermo-electromotive force produced by a moderate difference of temperature of the junctions is a parabolic function of that difference, or may be represented by such a function as

$$E = A + B\,(T_1 - T_2) + C\,(T_1 - T_2)^2,$$

where A, B, and C are constants for that pair of metals. It has been found, however, that a formula given by Holman in the form

$$\log E = M \log T + N,$$

fits the facts better for a larger range of temperature, M and N being constants for any chosen pair of metals and T being the temperature of the hot junction, the other being kept constant. This formula has the advantage of being linear; that means it is the equation to a straight line when plotted in terms of log E and log T, and hence can more easily be extrapolated.

The constants can, of course, be determined by measurements of the E.M.F. made with the hot junction at known temperatures.

Accordingly, if we have such a couple of metals selected so that a neutral point does not lie within the range of temperature over which it will be used, and if we calibrate the couple

by measuring the E.M.F. at three fixed temperatures, say 0° C., 100° C., and some much higher temperature, such as the freezing-point of lead, then we can use it for the determination of intermediate or somewhat higher temperatures. The method now always adopted is to read the E.M.F. with a high-resistance voltmeter

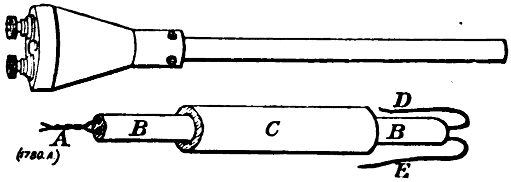

FIG. 14.—DIAGRAM SHOWING THE MODE OF INSULATING THE WIRES OF A THERMO-COUPLE.

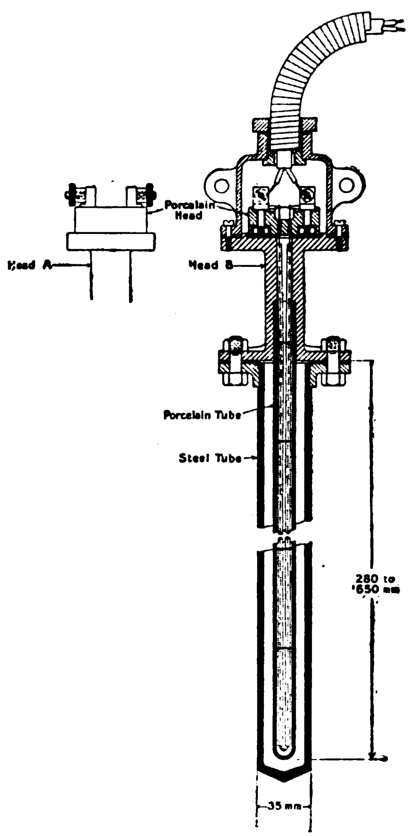

FIG. 15.—THERMO-COUPLE ENCLOSED IN A STEEL TUBE.
(The Cambridge Scientific Instrument Company.)

which has its scale marked directly to read temperature.

The metals chosen for the couple are in the form of wires of copper and nickel, or copper and constantan (a copper-nickel alloy) for moderate temperatures up to 1,000° F., and a couple of platinum with platinum alloyed with 10 per cent. of either iridium or rhodium for high temperatures.

Wires of the two metals are run down separate holes in porcelain or quartz tubes to insulate them, the ends are welded together at the bottom, and these tubes are then enclosed in a steel tube for safety (see Figs. 14 and 15). The wires are made long enough to connect to a high-resistance volt-meter, and these junctions are kept well away from the source of heat. If the lower closed end of the steel tube, where the thermo-junction lies, is placed in a furnace, it soon takes the surrounding temperature, and an E.M.F. is produced which causes a deflection of the volt-meter, generally a movable-coil instrument, and the temperature is read off directly in the scale. It is necessary that the cold junction should be kept at the same temperature, or if it alters that a correction should be applied. Messrs. Crompton in their pyrometer do this by providing several scales applicable respectively to the atmospheric temperatures marked on them.

These scales are graduated by placing the hot junction in regions of known temperature obtained from the melting or rather the solidifying temperatures of various metals. Thus, in addition to 0° C., and 100° C., we can use the freezing-point of molten lead = 327° C., the freezing-point of silver = 955° C., and that of gold = 1,064° C., which are known pretty accurately.

The commercial thermo-electric pyrometer in this form is a handy instrument, but when the couple is formed of base metals or alloys, such as copper-constantan, copper-nickel, or copper-steel, the couples need recalibrating at intervals, and are only available for temperatures up to about 800° C. for higher temperatures, the platinum and platinum-iridium (Pt + 10 per cent. Ir.) is used.

Such thermo-couples may be made self-recording by photographic devices. Thus, in the Roberts-Austen-Pitkin pyrometer the volt-meter is replaced by a high-resistance movable-coil mirror galvanometer, and a ray of light reflected from the mirror falls upon a slowly-revolving drum covered with photographic paper, which is driven round by clockwork. The variations in the deflections of the galvanometer are made to record themselves by a line marked on the paper; the ordinates of this line denote temperatures, and can, by proper calibrations, be interpreted into Centigrade temperatures (see Fig. 16).

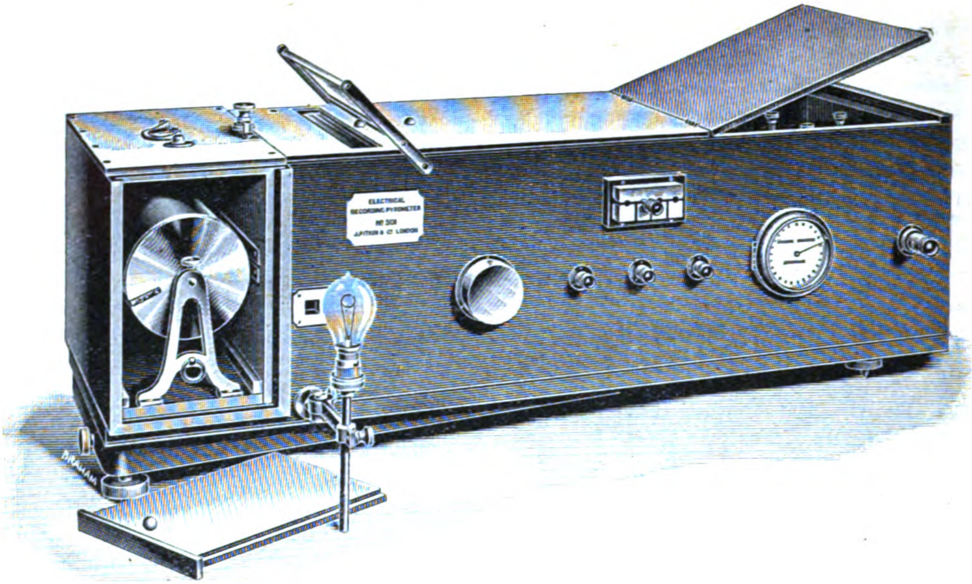

FIG. 16.—ROBERTS-AUSTEN PHOTOGRAPHIC RECORDING PYROMETER, AS MADE BY MESSRS. PITKIN AND WHITE.

The Cambridge Scientific Instrument Company have constructed an ingenious instrument called a thread-recorder, for the automatic record of thermo-electric pyrometers and other instruments (see Figs. 17 and 18). In this instrument a movable-coil galvanometer has a long light needle of aluminium attached to its coil, and this moves to and fro over a drum covered with paper. Between the needle and paper surface is an inky thread, and the needle swings just clear of the thread. At short intervals, by means of clockwork, a bar is brought down on the needle of the galvanometer, catching it in any position, and presses it against the inky thread and on to the paper. The exact position of the needle is, therefore, recorded by a dot on the drum, and the series of dots marks out the various positions of the galvanometer needle, and therefore records the temperature if a thermo-electric junction is connected to it.

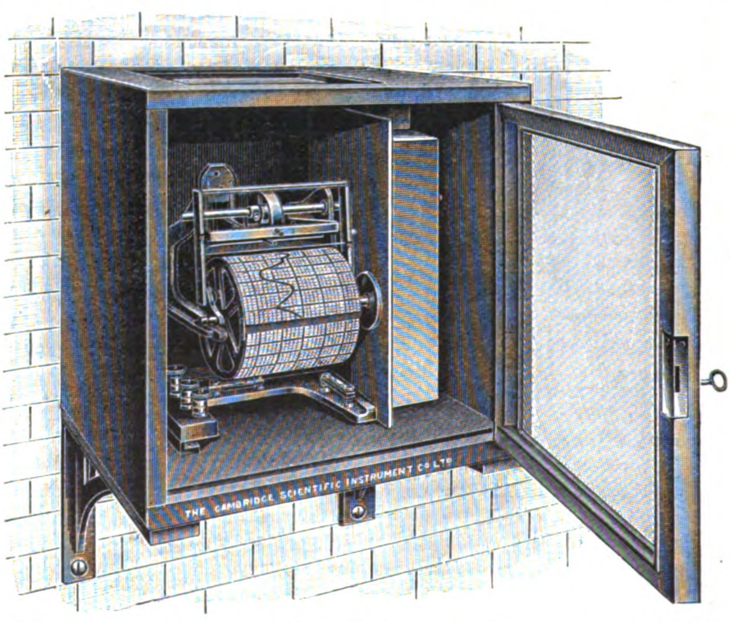

FIG. 17—THE THREAD-RECORDER OF THE CAMBRIDGE SCIENTIFIC INSTRUMENT COMPANY.

For accurate work, it is essential that the cold junction should be kept at a constant temperature, or else introduce an opposing E.M.F. into the circuit, which neutralises that due to the cold junction. An ingenious method of this latter kind has been devised by Messrs. Stroude and Josephs. It consists in introducing into the thermo-junction circuit an electromotive

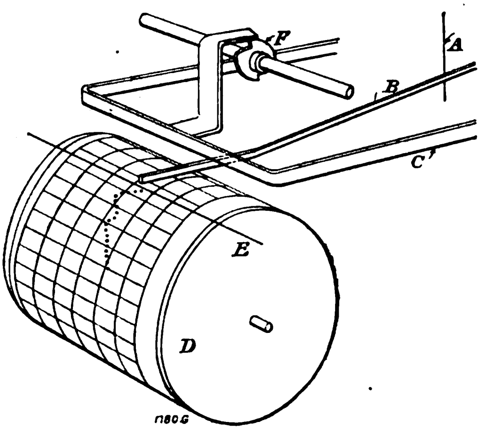

FIG. 18.—DIAGRAM SHOWING THE PRINCIPLE OF THE THREAD-RECORDER.

force which is created by any variation of the cold junction from a standard temperature, say, 5° C. A Wheatstone's bridge arrangement is formed of pairs of conductors of large and small temperature coefficients used as the opposite arms of the bridge. Hence, any variation of temperature creates an E.M.F. in the bridge circuit. The thermo-junction is inserted in this bridge circuit, and the bridge arms are placed in the same region as the cold junction and adjusted so that variation of temperature keeps a constant E.M.F. in the cold junction.

Lastly, we have to consider means for measuring higher temperatures than those which can be measured with a thermo-couple about (1,200° C.), and also cases in which the hot body cannot be approached.

For this purpose advantage is taken of the Stefan-Boltzmann law that the temperature of a radiating body varies as the fourth root of the radiation per second per unit of area.

If we form an image of a distant hot body by means of a concave silver metallic mirror, the intrinsic temperature of this image does not depend upon the distance of the object. For the total heat collected varies inversely as the square of the distance, and also the size of the image varies inversely as the square of the distance, so that the heat thrown per second upon a square unit of area of the image is independent of the distance.

If, then, we place in this focus of the mirror a thermo-junction which is more than covered by the optical image of the hot body, the temperature to which this junction will be raised will depend upon the temperature of that object but not upon its distance. If, then, the thermo-couple is connected to a galvanometer we can calibrate the scale of the galvanometer by exposing the junction to the radiation from various baths of solidifying metals which are at known temperatures.

Professor Féry has constructed on these principles a radiation pyrometer which, as made by the Cambridge Scientific Instrument Company, serves admirably to determine furnace temperature, and that of steel in crucibles at the moment of pouring, Bessemer converters, etc.

The instrument is like a short Newtonian telescope, and has a concave silver mirror at the closed end (see Fig. 19). This forms an image

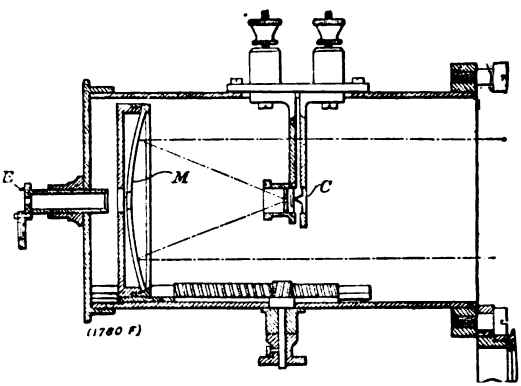

FIG. 19.—SECTION OF THE FÉRY RADIATION THERMO-ELECTRIC PYROMETER.

of the distant radiator at its focus, in which is placed a copper constantan thermo-junction in the form of a cross. This thermo-junction is protected by a small circular screen from the direct access of rays from the hot body. It is essential that the image of the hot body should rather more than cover this screen. To observe this the mirror is perforated with a hole and a suitable eye-piece placed in that aperture. The thermo-couple is connected to a single-pivot movable-coil sensitive galvanometer, which can be calibrated so as to read temperatures directly by exposing the instrument to the radiation from baths of molten metal just solidifying at known temperatures.

To determine a furnace temperature, an iron, fire-clay or porcelain tube closed at one end, has the closed end inserted into the furnace. The

radiation pyrometer is then adjusted so as to look down the tube and gather rays radiated from the closed end (see Fig. 20). This is practically black-body radiation, which follows Stefan's law, and the reading of the galvanometer gives us, therefore, the black-body temperature. If the radiating substance is one like carbon, steel, iron, copper, or lead, which is black or forms a black or dark-coloured object, we can take the temperature observed as the true temperature of the body.

If, however, the radiating body was a sheet of platinum in a state of incandescence, the real temperature of the body would be higher than that read on the galvanometer scale, because it is a poorer radiator at a given temperature than a black body.

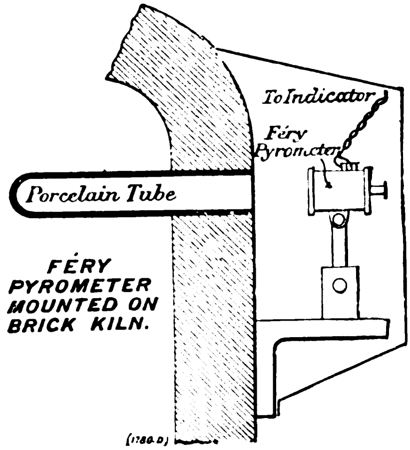

FIG. 20.—MODE OF USING THE FÉRY RADIATION PYROMETER.

By means of a thread-recorder galvanometer, as above described, a continuous record can be obtained of furnace temperatures far above the melting-point of steel. The applications of this radiation pyrometer in the Arts are innumerable, and enable us to ascertain and record the temperature of inaccessible places over a range between 600° C. and 2,000° C. with considerable accuracy.

In concluding this lecture it may be interesting to inquire what explanation modern electrical theory can furnish of the laws to which our attention has been directed. The theory of electricity which now holds the field with a considerable body of evidence in its favour is the electronic theory, which is based on the evidence that the agency we call electricity has an atomic character or structure. The atom of negative electricity is the *electron*. The electron is supposed to be a spherical structure in the æther, which is the focus of a number of converging lines of twist in the æther, and it can therefore be displaced without resistance through the stationary æther. The radius of an electron is, approximately, 10^{-13} centimetres, which is one-hundred-thousandth part of the average size of an atom. It represents a negative charge of electricity approximately equal to 3×10^{-10} of an electrostatic unit, or 10^{-20} of an electro-magnetic unit; it has a mass equal to 10^{-27} of a grain. In other words, one billion billion electrons weigh a milligramme, and 3,000 million carry an electric charge equal to one electrostatic unit.

The ratio of charge to mass, charge reckoned in electro-magnetic units, is 10^{-7}, whereas that of a hydrogen atom is 10^{-4}. The structure of the correlative positive electron is not so completely ascertained, but its diameter appears to be about 100,000 times greater than that of the negative electron, and its mass comparable with that of a hydrogen or helium atom.

Chemical atoms are complex structures of positive and negative electrons, from which, owing to rotatory or vibratory motions of the negative electrons, one or two of the negative electrons may be cast out.

Hence a piece of metal, such as a copper wire, must be thought of as a sponge-like structure consisting of complex arrangements of electrons forming the chemical atoms, each cubic centimetre containing about an equal number of free or detached negative electrons moving hither and thither in the atomic interspaces or jumping from atom to atom, with a speed on an average of sixty miles a second. The electronic theory shows that the sensible temperature of the metal is due to and measured by the mean kinetic energy of the free electrons alone, and that the conduction both of heat and electricity is also effected by the free electrons.

As regards flow of heat, if the electrons at one point have greater mean kinetic energy than at another, this energy density is gradually unified by the collisions of electrons with atoms and with each other, and this process constitutes the diffusion or conduction of heat. As regards electricity, the operation of an electromotive force applied to a conductor is to make an interior electric field, and this causes a movement of electrons in that direction which is superposed on their indiscriminate motion.

What we call the current in the metal at any point is the algebraic sum of the total number of free electrons passing through unit of area in the metal, and is measured by the product

of the mean velocity, the electronic charge, and the algebraic sum of the electrons so passing.

The heat produced in the conductor varies as the increase in the average kinetic energy of the electrons, and this varies as the increase in the mean-square velocity. Hence it follows that the heat produced by the current, which is the increase in the mean unidirectional kinetic energy produced by the electronic drift, must be proportional to the square of the mean electronic velocity, that is to the square of the current, and this is the statement of Joule's law. There is evidence that the energy of atomic motion, that is, of the atoms or complexes of chemical atoms, forms no sensible portion of the whole kinetic energy, and hence we may deduce Joule's law directly from the increase in electronic energy resulting from an applied electric force.

Starting from the assumptions that metallic conduction is effected by the movements of free electrons in the metal, and that these obey the laws of gas molecules confined in a vessel and have their velocities distributed in accordance with Maxwell's law, we can deduce Ohm's law, provided that the electric force applied to move the electron is not sufficient to cause a sensible change in the velocity of the electron between two collisions. According to Sir J. J. Thomson, the mean free path of an electron is about 5×10^{-7} centimetres, except in bismuth, where it is 10^{-4} centimetres. The mean free path of a gas molecule at ordinary temperature and pressure is 10^{-5} centimetres. In one cubic centimetre of copper there are about 10^{-23} atoms and about $1 \cdot 5 \times 10^{-23}$ free electrons. The mean kinetic energy of the free electron is the same as that of a free molecule of hydrogen at the same temperature.

Now, this theory is found to give a very accurate prediction and explanation of the known fact that the ratio of the electric to thermal conductivity in all metals is nearly the same and varies as the absolute temperature. We have then to explain how it is that rise of temperature in a pure metal reduces the electric conductivity. The current or electron drift produced by a given electric force or electromotive force per centimetre is proportional to that force and also to the time interval between two collisions of the electrons. The greater the speed of the electron, that is, the higher the temperature, the less therefore will be the electronic drift for a given electric force, and that implies that the conductivity or ratio of drift to force is reduced by rise of temperature.

Lastly, we may say that this theory of metallic conduction which ascribes all the phenomena to the operations of the free electrons has been able to give a good account of the laws of radiation enunciated by Stefan, Boltzmann, Wien, and Planck. The Stefan-Boltzmann law can be deduced theoretically by the application of Carnot's principle to the known fact that radiation exercises a pressure on black bodies on which it falls, and the laws of Wien have been deduced theoretically by Jeans from the electronic theory.

The results which are pretty generally accepted at the present time in reference to this subject may be briefly summarised in about twenty short statements as follows :—

1. According to the electronic theory, electricity has an atomic structure. The atoms of negative electricity are called electrons or negative corpuscles. They have each a mass of about $\frac{1}{1700}$ of that of an atom of hydrogen, and a diameter of about one billionth (10^{-12}) of a millimetre. This diameter is therefore about $\frac{1}{100000}$ part of the diameter of an hydrogen atom, or in the ratio of a pin's head to the dome of St. Paul's.

2. The nature of the atoms of positive electricity are not yet so completely determined, but they are much larger and heavier than negative electrons.

3. Chemical atoms or material atoms are structures composed of electrons, positive and negative, and from any chemical atom one or more negative electrons can escape or become free.

4. Conductors such as metals must be regarded as composed of chemical atoms, which are collocations of electrons in stable orbital motion, and a certain proportion of interspersed free electrons moving between the atoms, about equal in number to the atoms.

5. The electrons which are free must be regarded as jumping from atom to atom or colliding with them and as moving in all directions in the interatomic spaces with varying velocities distributed according to the same law as the velocities of gas molecules.

6. The mean kinetic energy of a free electron is the same as that of a free molecule of hydrogen at the same temperature.

7. The electrons have therefore a certain mean free path, and the laws of the kinetic theory of gases apply to them.

8. In 1 mm. cube of copper there are about 10^{20}, or 100 million billion copper atoms, and about 150 million billion free electrons ($= 150 \times 10^{18}$) moving with an average velocity of *sixty miles per second.*

9. The temperature of the conductor is determined solely by the mean kinetic energy of the free electrons, and in no sensible degree by the energy of motion of the chemical atoms or molecules.

10. Both conduction of heat and conduction of electricity are effected by the agency of the free electrons.

11. If one part of a conductor is at a higher temperature than another, then at the place of high temperature the free electrons have the greatest kinetic energy; but this inequality is gradually equalised by collisions of electrons, which is equivalent to the diffusion of the quicker-moving electrons amongst the slower-moving ones. Hence facility of electronic displacements implies good conductivity for heat.

12. Conduction of electricity is effected by the movements of the free electrons under electromotive force during their free period. This unidirectional drift of electrons is superimposed on the irregular natural motion of the electrons.

13. A current of electricity is measured by the number of electrons per unit volume multiplied by the static charge of each and by the mean unidirectional velocity or by Nev. The electronic charge is 3×10^{-10} of an electrostatic unit or 10^{-20} of an electromagnetic unit.

14. If, then, we create by E.M.F. an electronic drift, the increase in electronic kinetic energy or in sensible heat must be proportional to the square of the current, and this is Joule's law. Joule's law affords proof, therefore, that the sensible heat is due to electronic *vis viva.*

15. The mean free path of a free electron is, in most metals, about $\frac{1}{200}$ of 1μ or $\frac{1}{200000}$ of 1 mm. In bismuth it is about one hundred times greater. The mean free path of a gas molecule at 760 mm. is about $\frac{1}{10}$ of 1μ or $\frac{1}{10000}$ of 1 mm.

16. Rise of temperature, by accelerating electron velocity, shortens the time of free path, and therefore decreases the time during which electron drift or current can take place. Hence it increases resistance, which is measured by the ratio of E.M.F. to current.

17. Good conductors of electricity are therefore good conductors of heat, because in both there is either large free path or small mean velocity along that path. In both cases the large mean free path or small mean electronic velocity implies facility for electronic drift or opportunity for equalisation of kinetic energy, which implies good conductivity for heat and for electricity.

18. Moreover, it can be shown that the ratio of conductivity for heat to conductivity for electricity increases with and as the absolute temperature. At low temperatures the electric conductivity becomes very large. The calculated ratio for copper and many other metals agrees with experiment.

19. An electron radiates only when it is being accelerated or retarded. Hence at each collision it radiates, and rise of temperature, by increasing electronic velocity and number of collisions, increases radiation. Boltzmann and Larmor have both deduced theoretically Stefan's law. Also Jeans has derived Wien's and Stefan's laws from the electronic hypothesis.

20. We can also show by elementary reasoning that the theory of electric conduction which assumes the existence of free electrons in the metal with a certain short interval of time between the collisions of electrons and atoms tends to Ohm's law—viz., that the current is independent of the electromotive force at a given temperature. Hence the hypothesis generally is supported by the facts of Nature, and may be employed to visualise the processes and assist in forming clear conceptions of what takes place.

For fuller information on these important points of theory the reader may be referred to the following works:—

"The Electron Theory," by E. E. Fournier d'Albe.

"A Treatise on Electrical Theory," by G. W. de Tunzelmann.

"The Theory of Electrons," by H. A. Lorentz, where the reader capable of following mathematical discussions will find the most authoritative exposition of the applications of the electron theory to the laws of electric conduction and radiation.

THE STEEL INDUSTRY IN ITALY.

The steel industry of Italy of late years has developed considerably, having been previously so unimportant that nearly the whole of the iron ore from Elba, on which the industry is more or less dependent, was exported to the United Kingdom. The most important steel works of the country are now those at Terni, of the Siderurgica at Savona, the Alti Forni at Piombino on the mainland, opposite the island of Elba, and the Ilva Company's works at Naples. The Terni, the oldest of these, with a capital of about £725,000, owes its inception to the late Signor Brin, Minister of Marine, under whose auspices, with the aid of large advances of capital from Government, it arose in 1884. The object in view, which has been successfully attained, was to render Italy independent of foreign

countries for its armour-plating and other naval requirements. The Siderurgica, with a capital of about £1,280,000 between shares and debentures, was formed in 1900. Its operations are chiefly limited to the conversion of pig iron into steel, and to working the metal thus obtained into rails, etc. The pig iron is derived nearly all from the United Kingdom, Germany, and Spain, and the coal from the first two. The works of the Elba Company are situated at Portoferrajo, the chief town of the island, which possesses an excellent natural harbour. They comprise three blast furnaces, two Bessemer converters, and coke ovens. Both ingots and pig metal are shipped off, chiefly to Savona, where finished steel products or castings are manufactured therefrom.

Though ostensibly separate and distinct undertakings, the Terni, Savona, Elba, and Ilva companies, with a collective capital between shares and debentures (at their full value) of £4,560,000, are linked together, and constitute a sort of merger or steel trust. The works at Savona, Portoferrajo and Naples, although so far apart, are under the personal direction of one and the same managing director, Signor Cesare Fera. The Elba mines are thus called upon to supply yearly about 600,000 tons of ore, undoubtedly a formidable output for mines which are reputed to contain only nine or ten million tons of ore. Their exhaustion would thus seemingly be a question of another fifteen years' working, but it is stated that fresh deposits have recently been discovered in the island which will extend the life of the mines, in addition to some in Sardinia.

THE GUANO-PALM INDUSTRY IN HONDURAS.

It is the custom in Honduras, when clearing land for cultivation, to burn all growths, except marketable timber, and as guano-palm was considered valueless large quantities were destroyed. Notwithstanding this the supply is abundant. Prior to 1908 the value of this timber was practically unknown. On one of his periodical trips to Honduras for cargoes of dye and hard woods, the captain of a schooner was handed a piece of this wood for examination. Realising the possibilities for the development of an industry, he carried a larger sample to his principals in New York. On each successive voyage thereafter his cargoes have included large quantities of guano-palm logs. The tree requires a damp marshy soil for its best development, and frequently attains a diameter of more than 2 ft. It is not marketable above that size, however, while the minimum is 8 and 10 inches. It flourishes and is abundant along the lowlands of the coast. The wood in its natural state is exceedingly porous and light, but damp and soggy. To prepare it for commercial use it is put through an evaporating process to extract the moisture, thereby greatly reducing the weight, so that it is not only lighter than ordinary cork, but a given weight is capable of being compressed into much smaller bulk. It is used pulverised and in slabs. Lately the commercial possibilities of the wood have become known, as indicated by advertisements in trade journals offering for sale life-preserving equipments made from guano-palm. Planters in Honduras are awakening to the possibilities of the tree, and one banana grower, who annually clears a large acreage for banana cultivation, is about to send a representative to close a contract with New York importers for a cargo of 150,000 ft. of guano-palm. A recent enquiry from the same market calls for 1,000,000 ft. The greatest drawback to the rapid execution of orders is the difficulty of transportation.

THE ECONOMIC CONDITION OF JAPANESE SAGHALIEN.

The Island of Saghalien was occupied by the Japanese forces in 1905, and their possession of the island south of the fiftieth parallel was confirmed by the treaty of peace with Russia in October of the same year. Of the industries of the island, the one that has from old times been the most developed and important is fishery. The development of the herring fishery has of late been especially marked, and is now at the head of the industry, and next to it comes the trout and salmon fishery. With respect to the catch of these fish, the special right of laying nets, that is, the seine fishery right, is granted within definite limits of the sea, while for other fish it has been decided to allow fishery in common. Cod fishing is carried on to a considerable extent, and this is followed by crab fishing. The latter has developed remarkably, and the crabs caught are all tinned and chiefly exported to America. About 10,000 cases (four dozen in a case) of tinned crab were produced in 1909. To prevent the diminution of important fish, such as herring, trout, and salmon, the number of fishing grounds off the island is restricted to three hundred and forty-two. An experimental fish farm has been established on the western coast, where investigations and researches of various kinds are being carried on. Upon the cession of the island to Japan, general investigation was made respecting its agricultural capacity, with the result that it was ascertained that there were many tracts suitable for cultivation and pasturage, and that both soil and climate are favourable. Accordingly, since 1906, agricultural settlers have been quartered in suitable localities, and domestic animals and various seeds have been provided for them. At present, according to a Japanese report, the chief products of the island are wheat, barley, oats, rye, pease, potatoes, hay, and vegetables. According to the investigation of the mining products of the island made since 1905, the principal product of the island is coal, next to which are alluvial gold and iron pyrites. Coal is especially abundant, and is of good quality. There are three important coalfields in the island, namely, the

northern, the middle, and the southern coalfields, besides many others of less importance. The greatest of them is the middle coalfield, which extends from the River Pusutaki, a tributary of the Susuya, to the River Tomarioro, the length being sixty miles, and the width varying between one and three miles. The northern coalfield lies along the eastern side of the mountain range of Karafuto, extending from near the mouth of the River Poronai to the Russian boundary. The southern coalfield is situated in the central portion of the Notoro peninsula. Alluvial gold abounds in the beds of the rivers which come down from the Taraika, Susuya, and Shiretoko mountain ranges. Iron pyrites are found in large quantities in the Notoro peninsula. In 1907 oil was discovered in the neighbourhood of Tokombo and Arakoi on the western coast. The forests are virgin, and of an extent unequalled in other parts of the Japanese Empire.

THE WOOD-ALCOHOL INDUSTRY IN GERMANY.

The wood-alcohol industry in Germany made slow progress until 1880, when the law providing for the denaturation of alcohol was passed, but about the same time the importation of wood alcohol and pyrolignite of lime from the United States began, and a number of the wood distilling firms merely bought up these imported raw products and manufactured them into acetic acid, methyl alcohol, and denatured wood alcohol. The largest concerns, however, soon established their own distilling plants in the thickly-wooded surrounding countries of Galicia, Hungary, and Russia, and imported their raw products to their refining plants in Germany. Exact figures of the production of wood alcohol and pyrolignite of lime are not published, but according to a reliable estimate there were produced in a recent year, in Austria, Hungary, and Germany, about 6,500 metric tons of the former and 27,000 to 28,000 metric tons of the latter. The industry has also suffered somewhat of late years on account of the competition with the great volume of denatured potato and grain alcohol produced in Germany. The fact that deciduous varieties of wood are comparatively scarce in Germany is another reason why the wood-alcohol industry is not so far advanced. Chemists and distillers state that wood from coniferous trees produces only about one-half the wood alcohol and pyroligneous acid produced by wood from deciduous varieties, and that the profitable distillation in the former case depends upon the quality and quantity of the pine oil and tar obtained. On account of the costliness and general application of these woods the stumps of coniferous trees are practically all that are distilled. The distillation of sawdust and wood refuse has not proved profitable, because practically all these products in Germany come from coniferous woods, which not only produce little alcohol and pyroligneous acid, but very little tar and pine oil. The charcoal obtained in the distillation of sawdust, which is the only other product of possible commercial worth, is comparatively valueless, because it is in powder form, and efforts to obtain it in briquette form have as yet proved unsuccessful.

ARTS AND CRAFTS.

The Exhibition at the Design Club.—The Design Club, which has recently moved into new and more picturesque quarters at 106, Great Russell Street, held an exhibition of members' work early in June. As the greater number of the artists belonging to the club are designers for various kinds of manufacture, it is not often that there is a chance of seeing their work with any very certain knowledge of who is really responsible for it. The little show at the club-rooms, however, afforded an opportunity both of seeing what certain men are doing, and of realising the lines along which some of the best trade designers are moving. Amongst the repeating patterns shown at Great Russell Street may be mentioned some interesting wallpaper and cretonne designs by Mr. Lindsay P. Butterfield, more closely allied to "the styles" than a good deal of his work; a little group of patterns by Mr. Sidney Hayward, one or two of which were more restrained and less naturalistic than the work one habitually connects with his name; some good carpet designs and sketches by Mr. Alfred Carpenter; some rather effective velveteens by Mr. Napper; a few clever, if not very tasteful, patterns by Mr. Wilcox; and a couple of very dainty and workmanlike little sketch designs for tablecloths, destined for round and oval tables, by Mr. Gordon Hunton.

Amongst the designs for stained glass were two or three figure panels by Mr. T. Erat Harrison, and some very decorative and convincing ships by Mr. E. Ingram Taylor. Mr. Amor Fenn's episcopal cross and his design for ironwork at the Wesleyan Church House were both distinctive and workmanlike, and Mr. Alfred de Sauty's bookbindings, without shouting in any way, compelled attention by their individuality, their freshness, and the unusual appreciation of balance and proportion displayed in them. The original of the Garden City poster by Mr. Tom Taylor proved how much better a good original is than even the most successful reproduction can hope to be, and Mr. C. F. A. Voysey's rug design was a very clever and amusing bit of artistic playwork. The names of one or two of the members of the Design Club are familiar to most educated people with any pretensions to artistic culture; those of the majority are known only to the few immediately interested in applied design. The exhibition, when one considered it in that connection, gave one rather a feeling of depression. Here is accomplished and often really artistic work done by men of whom the general public have never heard, while the

names of half a score of workers in the artistic crafts, far less accomplished and no better artists, are quite well known.

Textiles and the Coronation.—The Coronation has, of course, been a good opportunity for seeing what the British textile manufacturers are doing. Their forces were called into action not only for the decoration of Westminster Abbey, but also for the clothing of those who took prominent part in the ceremony, and there seems to have been a very strong desire on the part of those concerned that, at any rate on an occasion so bound up with the nation's life as the crowning of its King, an opportunity should be given for British workers to show what they could turn out. The patterned carpet in two shades of blue laid in the centre aisle of the nave was made by Messrs. Templeton, and is certainly a fine bit of weaving, whilst the colour and texture of the plain carpet by the same firm which covered the floor of "the theatre" left nothing to be desired. Messrs. Lister's velvet (deep blue on a buffish ground shot with silver), which covered all the galleries of the Abbey, and formed the main part of the decorations, was a good copy of a worthy Italian model, and did not clash with or unduly pronounce itself against the surrounding stonework. The fine tissue hangings on either side of the altar, whose many colours blended into a most harmonious whole, reminiscent of the damask background to some primitive Italian picture, were woven by Messrs. Warner & Sons, while the very happy rendering of the seventeenth-century Genoa velvet on the chair at Knole, which covered the recognition chairs, was by the same manufacturers. The effect of the deep green (almost black) and buffish velvet on the pinkish red ground is fine in itself, and is wonderfully helped by the skilful employment of the "Terry" outline. The design of the damask for the thrones of the King and Queen is a very good example of William Morris's work, and its colour, which looks a trifle dingy in the subdued light of the Abbey, is quite beautiful when seen in the bright sunlight. The large and dignified woven patterns of the copes of the Archbishop of Canterbury and the Bishop of Peterborough were taken by Messrs. Warner from old Italian designs, but the patterns are thoroughly good, and the effectiveness of the open ogee pattern worn by the Bishop of Peterborough owes a great deal to the skill with which it has been treated. It cannot, perhaps, be said that the Coronation has done much to stimulate original design in textile fabrics. A good many of the more serious and dignified patterns are certainly founded on old models, but the greater number of the sprig designs and other light decoration used for ladies' dresses are new, and these have afforded an oppportunity, which Messrs. Warner, and probably other firms, have not been slow to take, of showing what beautiful work can be done in England in the way of brocading on a damask ground in coloured silks and gold and silver thread by means of an extra shuttle. When effects like this can be got in the loom, a certain kind of embroidery ceases to be worth while.

Embroidery for the Coronation.—In one way and another the Coronation has been responsible for a good deal of embroidery, good, bad, and indifferent. The most monumental pieces of needlework are, of course, the frontal and dossal presented to the Abbey by the King and Queen, and carried out by Messrs. Morris & Co. from designs by Professor Lethaby and students of the Royal College of Art. The time allowed for the working of these important pieces of embroidery has necessarily been short, and when one remembers that so late as the beginning of the year it was commonly said by those who might be supposed to know that the work had been entrusted to quite different hands, it is surprising that it has been carried out so satisfactorily. On the other hand, it is rather to be regretted that in the twentieth century our ideas of fitting altar hangings for the great Abbey Church of Westminster cannot soar beyond the reproduction of the setting out of a late fifteenth-century frontal, which, though good in its way, is not remarkable for any particular beauty of design, and the introduction into these surroundings of archaic figures suggesting, alike by their drawing and their workmanship, a considerably earlier date. Of course, a conspicuously up-to-date design would have looked singularly out of place in the Abbey, but it would surely have been more fitting if the gift which will go down to posterity as commemorating the crowning of a twentieth-century king had borne some more characteristic marks of its own period. The embroidered arms in the thrones of the King and Queen and the chairs of the Duke of Connaught and Prince Arthur of Connaught have been executed by Messrs. Morris from designs by the Rev. E. E. Dorling, and they are good examples of heraldic treatment, free from the heavy padding and various other vulgarities which so often mar work of this kind. The great part of the design has in each case been carried out in stitchery, but the garters, the mounds, and the ermine are in appliqué.

The Prince of Wales's chair, for which Messrs. White, Allom are responsible, deserves separate mention. The problem before Messrs. Morris was how to get a large quantity of embroidery carried out at short notice in a creditable manner, and they have solved it satisfactorily enough. What Messrs. White, Allom have set themselves to do has been to see how perfectly the design on one chair could be executed, and their success has been complete. The Prince of Wales's arms, worked for them, from the design of Mr. Dorling, in the embroidery room of the Community of S. Mary the Virgin at Wantage, is a wonderful bit of workmanship. The drawing throughout is well preserved. The heraldic beasts are full of vigour and go, and the unicorn, executed in silver thread couched with a variety of tints, is as full of colour as is the pearly silver lining of a delicate shell. The texture of the ermine, too, is cleverly and not too

naturalistically rendered in stitchery. In short, the whole thing is a good example of the very best type of heraldic work.

Students' Carving.—The armoire presented to the King and Queen by the students and teachers of the School of Art Wood-carving, was on view at 39, Thurloe Place for a few days before it went to Buckingham Palace. It was designed by Mr. Grimwood, the chief instructor, and though more or less in the style of François I. work, it bears traces of its modern origin. The cabinet was planned so as to give a number of students in different stages of progress an opportunity of showing what they could do; and some of the mouldings and other simpler parts were executed by students almost at the beginning of their careers, whilst the linenfold side panels and the Royal Arms of the central door gave ample scope to more advanced workers. The carving, which was the work of *bonâ fide* students, gave a very good proof of the thoroughly practical teaching provided by the school.

EMPIRE NOTES.

Imperial Unity.—Among the many recent contributions to the discussion of the subject of Imperial unity, one of the most important is that supplied by the publication of Mr. Richard Jebb's new book on "The Imperial Conference," in which he gives a carefully-compiled history of the proceedings of the five conferences, commencing in 1887, tracing their development as a constitutional institution. He has also dealt with some of the events in the intervals between the meetings, in order to present a complete and comprehensive view of the difficulties which have to be met if the movement is to be the success we all desire. There is no question that the holding of these conferences has done much to promote union between the various parts of the Empire, but a great deal more will have to be done before the Empire attains that organic unity which is the ideal of the Imperialist. The present conference clearly shows that the Oversea Dominions will not be content with occasional pourparlers if they are to be regarded as partners in the business of Empire, who must bear their fair proportion of its burdens. As a step towards the solution of the problems which surround the question of Imperial unity and how it may be best effected, the study of Mr. Jebb's work is necessary, and its issue therefore timely. The same may be said, though the theme is essentially different, of Mr. Charles Bright's book on "Imperial Telegraphic Communication," as upon the facilities of telegraphic communication throughout the Empire much depends for the creation of that spirit of union which must be based upon mutual understanding, which can only be brought about by close and constant intercourse.

An Australian Solar Observatory.—Reference has been made in these columns, on more than one occasion, to the necessity of establishing a solar observatory in Australia, so as to complete the round-the-world chain of observatories, in order that the sun may be watched throughout the whole of the twenty-four hours. A definite forward movement has now been taken to this end by an appeal which has been issued by the British Empire League for funds for the purpose of helping to establish the Australian observatory. It is hoped that the appeal will be successful, and that the balance required, £6,000, will speedily be raised. Such an observatory, it is stated, would ensure that the four great centres of solar work—the British, American, Indian and Australian—would be conducted by English-speaking peoples. In this connection it is interesting to note that the Canadian Government are arranging to establish an observatory in the Cariboo district of British Columbia, which is to be equipped as thoroughly as that of Toronto, so that it may be of service to the new university at Vancouver.

A Co-operative Scheme for Alberta.—Mr. J. L. Stephens, a United States capitalist, has organised a Co-operative Farming Company for Alberta, which, in some of its features, is similar to a scheme of federative farming reported in the columns of a London journal recently. Under Mr. Stephens's scheme, although there is but one farm, there may be many proprietors. These may be composed of the employees themselves, who will be paid for their work according to its value, and who will also be able to draw their share of dividends for the money they may have invested in the undertaking. The farm will be under the care of an expert scientific farmer, who will be expected to give instruction to those who may enter into the service of the company as employees, and yet at the same time be themselves part-owners of the estate. In this way a man who has had no previous experience on the land may acquire a knowledge of farming, and eventually be able to make a start on his own account, using the capital which he may have invested in the company for that purpose. Of course, very much will depend upon the management, but the principle of the proposal, which is an important development of the share system in vogue in various parts of the Empire, appears to be a sound one.

A Canadian School of Commerce.—In the coming autumn, a school of commerce, similar in character to the schools established in London, Birmingham, Harvard, and Chicago, will be opened at McGill University, Montreal. The object of the school is to enable young men who cannot take a full college course before entering business to supplement their school education by a two years' course of special studies. The decision to open a school of the kind was reached after experiments on a small scale, during the last few years, which revealed a demand for such teaching by school graduates.

Exploration in Western Australia.—Mr. C. P. Conigrave, F.R.G.S., who was formerly Assistant

Curator of the Perth Museum, is now leading an exploring party in the north-west of Western Australia. He reports that in his trip across the Ord River, through the pine forests near the South Australian border, he has found the fauna and flora to be prolific, but he regrets to note the great destruction, in the Wyndham district, of the white egret, for the sake of its plumage, and suggests that steps should be taken to put a stop to it. Mr. Conigrave's party is following up the work done, a few years ago, by Mr. F. S. Brockman and others, but he proposes to explore a part of the country into which no white man has yet entered—a country well watered and fertile, which, in years to come, will prove to be one of the richest districts of Western Australia.

Shipbuilding in Victoria.—Melbourne is evidently determined not to allow her great competitor, Sydney, to dominate the shipbuilding enterprise of Australia. It is proposed, therefore, that a start be made at Williamstown with the establishment of shipbuilding yards, and official inquiries are to be instituted with the object of discovering the best means of improving and developing the outer ports of Victoria. The Premier, the Hon. J. Murray, who is at present in London, says, "We must have our own properly-equipped shipbuilding facilities, in order that we may be able to compete with any of the other States in this direction, and to deal not only with our own mercantile marine, but with any other large shipbuilding projects which may be afloat."

Emigration.—The standing committee appointed by last year's conference on emigration, the holding of which was first suggested at a meeting of the Colonial section of this Society, has issued a report, which has been submitted to the Imperial Conference. In it they recommend that full consideration should be given to the problem of emigration within the Empire, and that, should the Imperial Conference be unable, as the case has proved, to attend to the subject in detail, a subsidiary conference should be formed for the purpose. They further suggest that an official committee be appointed representing the various emigration societies of the United Kingdom, the chairman of which, and representatives of the chief departments concerned, should be nominated by the Government. The Dominions Governments might also nominate representatives. The functions of the proposed committee would be, among other things, to co-ordinate the emigration societies of the United Kingdom—a very desirable undertaking—and to deal with the labour exchanges, distress committees, and other bodies, on all matters connected with emigration. In an appendix the report treats of the emigration of single men and families, of women and of children, and emphasises the special importance of redressing the anomalies of female population in the Mother Country and the oversea States, and of encouraging the emigration, under properly constituted authority, of workhouse and orphan children. In view of the immediate need of Australia, New Zealand, and Canada for people, and of the prevalent unemployment and distress in the homeland, which is persistent if in degree variable, the suggestions of the standing committee are worthy of the careful consideration of the home and colonial authorities, and of all who are interested in the maintenance and defence of the Empire.

Tin in Rhodesia.—A discovery of tin in Rhodesia, near Salisbury, is reported. The ore has been located over an area of twenty square miles, and is said to give results up to 5 per cent. of metallic tin. The value of the find is stated to be confirmed by engineers and tin experts. If the operations for proving the ore, which are now in progress, turn out successful, the discovery should be of great value to Rhodesia and to South Africa.

NOTES ON BOOKS.

Manual of Library Bookbinding. By H. T. Coutts and G. A. Stephen. London: Libraco, Ltd. 7*s.* 6*d.* net.

Though many books have been written on bookbinding, they all, or nearly all, deal with that more distinguished section of the craft which devotes itself to the encasing of books in leather, and the decoration of the encasement. And yet, for every single volume that is carefully and honourably clothed in the more ancient manner, there must be thousands which are rapidly sewn and squeezed and packed into their shells of card and calico, to be hurried out into the world for a fleeting and transitory life. Despite the difference in intention and result, the new process is no less skilful than the old, but the skill has passed from the workman to the designer of the machinery. In this, as in all modern industrial processes, the workman has become an operative. He does not execute any work at all. He "operates" or "minds" a machine which does a part of the work. The finished article is the result of the efforts of a number of machines, and the better the machine the less the intelligence required to "mind" or look after it. The manufacture of a modern book, like the making of a modern bale of calico, requires the service of a number of machines of the highest ingenuity. The nature of these machines, the manner of their employment, and the results of their labours form the subject of the volume under review. It gives a very full and clear account of the various methods by which a book is turned out and of the materials employed. It provides much useful information and many practical hints for the benefit of librarians and others who have to employ binders; and, on the whole, it may be recommended as a very complete and serviceable treatise on a subject of interest and importance.

SILK: ITS PRODUCTION AND MANUFACTURE. By Luther Hooper. London: Sir Isaac Pitman & Sons, Ltd. 1s. 6d. net.

This volume forms the eighth of the series known as "Pitman's Common Commodities of Commerce," an excellent set of little handbooks which have already dealt with coffee, tea, cotton, sugar, oil, rubber, and iron and steel. Mr. Hooper, who is well known as a writer and lecturer on the subject of weaving, gives a very concise and interesting account of silk. Starting literally *ab ovo*, he describes the various species of silk-worm, their anatomy, and the manner in which they are cultivated; this is followed by chapters on the history of silk and sericulture, reeling from the cocoons, silk throwing and winding, dyeing, varieties of the silk thread, ancient silk weaving, the webs of China, satin damask weaving, and so on until the last chapter, which treats of modern silk weaving. The book is written in a very simple style, which, with the illustrations, renders it easily intelligible, even to those with no technical knowledge of the subject.

GENERAL NOTES.

INTERNATIONAL CONGRESS FOR SANITARY DWELLINGS, DRESDEN.—The Third International Congress for Sanitary Dwellings will be held at Dresden from October 2nd to 7th, 1911. The congress is divided into nine sections as follows:—

Group A: General.—Section I. Town-planning (building, forms of country settlement, garden cities, width of streets, height of building). Section II. Construction of buildings (planning, distribution of space, building material, foundations, basement, kitchens, lavatories, floors and ceilings, staircases, lifts and roofs). Section III. Internal arrangements (lighting, heating, ventilation, furnishing). Section IV. Sanitation (cleaning, removal of refuse, disinfection).

Group B: Dwelling Houses.—Section V. Dwelling houses in towns. Section VI. Dwelling-houses in the country.

Group C: Special Kinds of Dwellings.—Section VII. School buildings, boarding-schools, prisons, hotels, lodging-houses, hospitals, convalescent homes, baths, churches, theatres, and other public buildings. Section VIII. Workrooms and workshops, means of communication and transit (railways, tramways, ships, vehicles, etc.).

Group D.—Section IX. Legislation, executive, statistics, etc.

INTERNATIONAL SOCIETY FOR THE PROMOTION OF COMMERCIAL EDUCATION.—A meeting, organised by the International Society for the Promotion of Commercial Education, is to be held in London from July 24th to August 12th. It consists of some fifty lectures and a series of visits to places of commercial importance in and around London. The lectures are to be given each morning at the London School of Economics. They will describe the actual conditions and methods of British industry and commerce. The lecturers are leading business men and university teachers who have a practical knowledge of the subjects upon which they are lecturing. Among them are Mr. Mackinder, M.P., Mr. Lees Smith, M.P., Sir Laurence Gomme, Mr. Steele (of Parr's Bank), Mr. Birgood (of the Edinburgh Life Assurance Company), Mr. Hirst (editor of the *Economist*), Mr. Jeans (editor of the *Iron and Coal Trades Review*), Mr. Dunstan (of Wye Agricultural College), Mr. Ben Morgan (Trade Commissioner to Australia), Mr. Chiappini (Trades Commissioner to South Africa), and other well-known men. In the afternoons the students will visit docks, warehouses, factories, etc., and a whole day excursion to Birmingham will be made. The meeting is under the patronage of the London Chamber of Commerce, the London County Council, the University of London, the Royal Society of Arts, and other societies. A strong executive committee are arranging the details of the meeting; they expect to have at least 150 students. The fee for the course of lectures is £3. The committee would be glad to know of factories, warehouses, and other places of commercial interest in London which may be visited by the students. All who are interested in the meeting are invited to write to the Organising Secretary, Mr. E. Cleveland-Stevens, at the London School of Economics, Clare-market, W.C.

THE RUSSIAN SALT INDUSTRY.—The production of salt is classed among Russia's principal industries, and it may be said to be centred in the Odessa district, two-thirds of the total output being produced there. It is the production of salt in that district which has made it possible almost to exclude the foreign article from Russian possessions on the Baltic, and which will probably exclude it from the White Sea as well. The beginning was made last year to export from Eupatoria its best salt, which had been kept for several years in open stocks, to the Far East, there to be used in curing salmon and cod, to supersede Japanese salt. In Russia's easternmost possessions, on the Vilui River, an affluent of the Lena, there are wonderful masses of the purest rock table-salt overhanging the river to a height of 150 feet or more, but the means of transport are not likely soon to attain that development which will permit this salt to be shipped to the Pacific coast. The little increase in the output of table-salt in Russia is explained by the comparatively small requirements in the country for the production of soda and kindred industries. There are three ways in which salt is produced in Russia, viz., raking out the salt crystals which fall to the bottoms of the numerous salt lakes during dry seasons, rock-salt mining, and the evaporation of the brine obtained from deep wells. The total amount of salt produced in Russia in 1909 was 2,489,000 tons.

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FRIDAY, JULY 14, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

CHAIRMANSHIP OF COUNCIL.

On Monday, the 10th inst., at their first meeting, the Council elected LORD SANDERSON, G.C.B., Chairman for the ensuing year.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE APPLICATIONS OF ELECTRIC HEATING.

By Professor J. A. FLEMING, M.A., D.Sc., F.R.S., M.Inst.E.E.,

Pender Professor of Electrical Engineering in the University of London.

Lecture II.—Delivered March 13th, 1911.

THE APPLIANCES AND PROCESSES OF ELECTRIC HEATING.

The simplest method of heating a substance electrically is to pass an electric current through it. If the body has sufficient but not too much conductivity, it will be heated, and if we can prevent this heat from being removed we can raise the temperature to any degree. This method is called *resistance heating*. If the substance under treatment is not a conductor, it can be heated by passing the current through another resistance in contiguity to it. This resistance must be refractory and non-oxidisable at high temperatures. Very few materials possess all the qualities necessary for such a heating resistance. Platinum is almost the only pure metal which has them all.

Certain baser metals, such as iron, nickel or alloys, can be used up to temperatures not much above red heat, but are slowly acted upon by the atmosphere. An alloy called nichrome—a nickel chromium steel—is, however, extensively used as a heating resistance, and seems to endure heating to a red heat for a considerable time without destructive oxidation. A material called silundum has also come into use lately as a resistance material. It is prepared in an electric furnace. Carbon rods are packed in a crucible with a material which is principally silicon carbide (carborundum) and boron carbide, and when heated to 1,600° C. or 2,000° C. these carbides volatilise and impregnate the carbon. This converts it superficially into a material which does not oxidise at a red heat. The resistivity of silundum is approximately three times that of carbon. When prepared the carbon rods, now called silundum, are fixed in a metal frame, and can be heated without injury to a bright, red heat.

Granulated graphitic carbon, mixed with carborundum and certain silicates, is also used as a resistance material, and is known under the name *kryptol*.

Except in those cases in which the material to be acted upon itself forms the conductor, we may say that the above short list comprises almost all the materials suitable for forming the resistance in which the heat is generated by the passage through it of a current. The current may be created in this conductor either by the direct application to it of an external electromotive force, or it may be induced in it by the action of an alternating current in a neighbouring circuit. This last method is called *induced heating*. The direct and inductive methods can be combined together. The second method, although first in point of priority for producing heat electrically, is by means of an electric arc.

We may expose a substance to the direct radiation from a powerful electric arc or arcs, and in that way raise it to a high temperature, provided it is a black body or good absorber. On the other hand, we may form the arc against the substance to be heated by making it one of the electrodes of the arc, and, lastly, we may combine together the resistance-heating and arc-heating by making the substance to be

heated one of the electrodes, forming the arc against it, and then bringing the other electrode into contact with the substance to be heated.

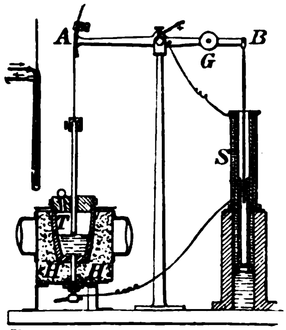

FIG. 21.—SIEMENS' EARLY ELECTRIC ARC FURNACE FOR STEEL MELTING.

As this was one of the earliest methods in point of time, we shall begin by considering this electric *arc heating* in its various forms.

Sir W. Siemens, in 1879, was the first to construct an electric arc smelting furnace, and apply it in metallurgy. Through the bottom of a crucible of fireclay or plumbago he passed a hard carbon and connected it to the positive pole of a direct current dynamo (see Fig. 21). The crucible was filled with fragments of iron or steel. The negative pole was a water-cooled iron or copper rod, which could be raised or lowered through a hole in the crucible cover. On making contact an electric arc was formed, which soon melted the metal. Using a current of 36 amperes, Sir W. Siemens found he could melt 22 lbs. of steel in an hour, and his estimate of the cost was that with a steam-driven dynamo 1 lb. of coal burnt in the furnace of the boiler would melt 1 lb. of steel in the crucible. This proved that in economy of working the electric furnace could compete with the regenerative gas furnace. Although this encouraging result was arrived at in 1879, it was not until the production of large electric currents had become an every-day matter that attention again became directed to the advantages of the electric furnace. Nearly twenty years later, in 1898, the subject was again taken up by Major Ernest Stassano, an Italian Artillery officer, who has devoted much time during the last twelve or fifteen years to perfecting a form of arc furnace for steel-making. In its most recent form it consists of a drum-shaped iron vessel, lined with refractory brick, and closed by a dome-shaped roof (see Fig. 22). Two or three carbon electrodes are inserted through the sides, these meeting in the middle, and being moved in or out by means of hydraulic cylinders. Between these carbons a single or three-phase arc is formed. The metal to be melted is placed in the hearth below the arcs, and the whole furnace is supported in an inclined position and rotated so as to mix the contents when fluid.

In the Stassano furnace the heating is produced by radiant heat from the arcs, so that the metal itself is not contaminated by touching the incandescent electrodes. As on this occasion we are concerned with the methods of heating rather than the results, we shall defer until the next lecture any discussion of the economical aspects of this furnace when used for steel manufacture. The next type of arc furnace is that developed by M. Paul Héroult, who in 1879 directed his thoughts to this matter. Héroult was previously well known as the inventor of a process of making aluminium, to which we shall refer later; and he then turned his attention to the production of special alloys of iron with other metals, called ferro-alloys, by means of the electric furnace.

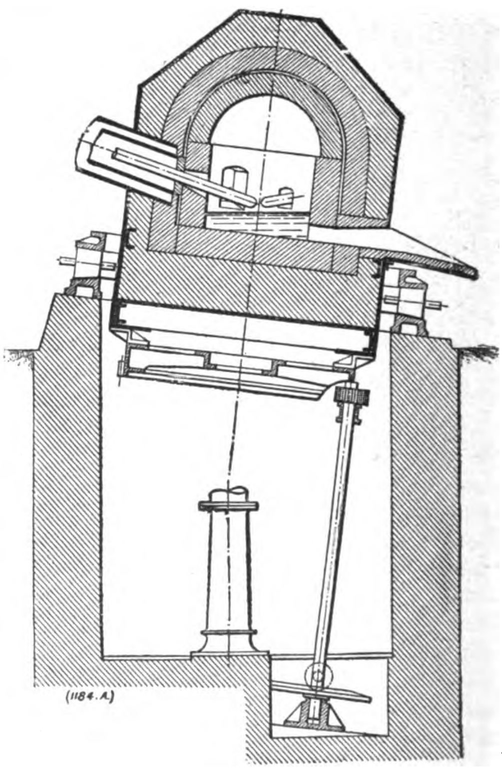

FIG. 22.—STASSANO ELECTRIC ARC FURNACE FOR STEEL MANUFACTURE.

Héroult has designed two distinct forms of electric furnace—one a form of electric blast furnace for the production of pig-iron from ore,

and the other a tilting crucible furnace for steel manufacture.

The latter consists of a sort of iron vessel, well lined with refractory bricks, made of magnesite or dolomite. The furnace is mounted on trunnions, by means of which it can be tilted, and the contents emptied over a spout. There is also an inlet for an air blast. Over the furnace, and attached to it, there is an insulated support for carrying two massive carbon electrodes, which project through holes in the lid of the furnace and can be raised or lowered at pleasure by gearing driven by electric or hydraulic power. One of these electrodes is the positive and the other the negative carbon (see Fig. 23).

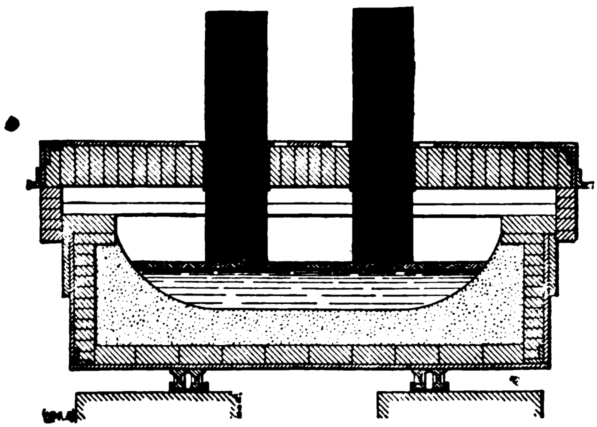

Fig. 23.—Héroult Electric Arc Furnace.

The furnace is worked in the following manner. A charge of steel scrap pig-iron, iron ore and lime is thrown into the furnace and the heavy graphite electrodes are brought down to touch it. When the current is turned on the charge is heated by resistance heating, and if the carbons are then raised two electric arcs are formed against it, which speedily melt the metal. The temperature is under control by adjusting the lengths of these arcs, and an air blast can be applied if required at the same time to oxidise the impurities.

Objections have been raised to this type of furnace that the cost of renewals of the roof lining is considerable, owing to the intense and destructive heat to which it is exposed. Also that, owing to the use of double (positive and negative) carbons there is risk of short circuits across the roof, inside or outside. These objections, however, have not been a barrier to the extensive use of this type of furnace.

Héroult has also invented a form of electric blast furnace for the production of pig-iron from ore. The furnace contains three carbon electrodes, by means of which current is passed through the coke charge near the mouth, maintains this at a red heat, and by means of the third electrode current is passed up the charge through the melted metal on the hearth to the upper layers.

Under certain conditions as to cheapness of electric power and nature of ores, such an electric-blast furnace can be worked commercially for the production of pig-iron from hæmatite coke and limestone, as in the ordinary blast furnace.

The French firm of Keller, Leleux & Cie have for many years carried on the business of producing calcium carbide, ferrosilicon and other ferro-alloys by means of electric furnaces, and they have developed a type of electric arc furnace for the reduction of iron ores. In its latest form this consists of a pair of cylindrical furnaces of iron, lined with refractory bricks, connected together by a tubular hearth at the bottom

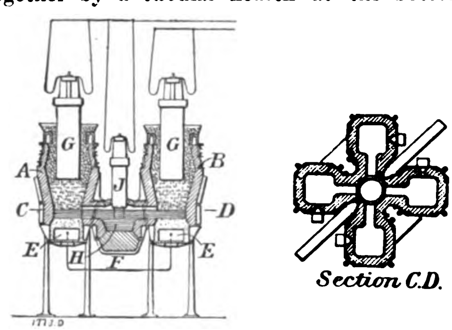

Fig. 24.—Keller Electric Furnace for Reduction of Iron Ores.

(see Fig. 24). In each of these cylinders is placed a large graphite electrode, G, and a

third, J, can, if desired, be inserted in the run of the connecting tube. The ore, coke and limestone are fed into these furnaces, and the heat generated by passing a current through the mass. As the iron ore is reduced the metal

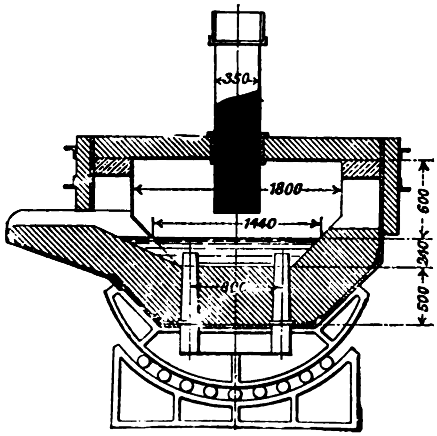

FIG. 25.—GIROD ELECTRIC ARC FURNACE.

collects in the hearth and is kept liquid by the heat generated by the current passing through it.

A steel refining furnace employed by the same firm does not differ essentially from the Héroult furnace in construction. A more recent type of arc furnace, for which greater simplicity is claimed, is that of M. Paul Girod, which is essentially a great, enlarged and commercial form of the first experimental arc furnace of Sir W. Siemens.

The hearth of this furnace consists of an oblong steel vessel with spout, lined throughout with refractory material, such as magnesite or dolomite. Through this lining pass one or more pieces of soft steel (see Fig. 25). These serve to lead the current into the molten metal lying on the hearth. These steel pieces may be made hollow, and be water-cooled. One or more carbon electrodes pass through holes in the cover or roof, but as these are of one polarity electrically, no short-circuiting can occur.

The charge can be heated by pure resistance heat by bringing down the carbon electrode to touch it, or an arc can be formed between the carbon and the charge, and either direct or alternating current can be employed. The roof or cover is lined with silica brick, the holes for the electrodes being fitted with a removable water-cooled frame. The Girod furnace can thus be either a resistance or an arc furnace, or both combined. The furnace is mounted on a semi-cylindrical base resting on steel balls in a similar concave base, so that it can easily be tilted over to pour off either the liquid slag or the metal charge itself. The ease of manipulation and of starting up, and general simplicity of construction, have given this Girod furnace a position of advantage. We shall consider more in detail in the next lecture the results of working and nature of the product.

Meanwhile, it may be said that one great advantage which these arc furnaces possess for steel refining is that they enable very hot and liquid slags to be produced. After the metal is melted and the slag collected on the surface, the carbon electrodes may be raised, so as to form the arc against the slag, and this soon renders it entirely fluid, so that it can be poured off before the charge is tilted.

On the other hand, there is always the possibility that carbon from the heated electrodes may enter the metal, and having regard to the extremely large variations in the quality of the finished steel, which are brought about by quite small changes in the percentage of carbon, it is highly desirable to have some methods of electric heating which are quite independent of electrodes, particularly as the cost of the large carbon electrodes is quite an important item in the working of the arc furnaces. This brings us to consider, then, in the next place, methods of resistance heating. These may be classified into methods of resistance heating in which the resisting circuit is the substance itself, which is being prepared, and next methods in which the resisting circuit is another material

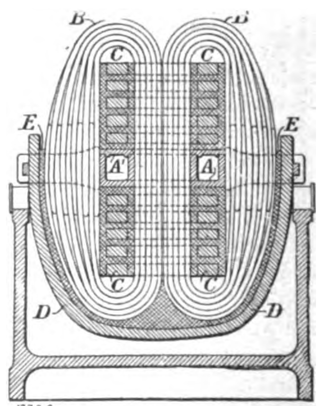

FIG. 26.—FERRANTI ORIGINAL INDUCTION FURNACE.

quite apart from the substance under preparation. Again, we may divide the methods into inductive or electrodeless heating and heating with current sent in from outside by electrodes.

The class of electric furnaces called induction

furnaces were first suggested by M. Ferranti. He proposed to construct an alternate current transformer with an iron core and primary coil traversed as usual by an alternating current (see Fig. 26). In place of the secondary coil he surrounded the iron core with an endless trough or channel, A, A, forming one complete turn of a secondary circuit. If this trough is filled with fragments of metal, and if an alternating E.M.F. is applied to the primary coil, an induced current will be created in the secondary circuit which will heat and finally melt the metal fragments forming that circuit. This current is created by the changing magnetic flux linked with the secondary circuit. Hence no electrodes are needed. The trough or channel which constitutes the secondary circuit must be made of refractory non-conducting material (see Fig. 27). Induction furnaces of this type have come into extensive use for the preparation of the higher and special grades of steel. It is not possible to secure in them such high temperatures as are producible in arc furnaces, but the temperature and operations are completely under control, and there is no possible source of contamination of the metal being melted. One of the best known of the induction furnaces is that invented in 1900 by Mr. F. A. Kjellin, a Swedish engineer. It consists of a massive rectangular iron core composed of thin plates of soft iron, insulated by non-conducting non-inflammable cement. Around this core is wound a coil of insulated wire, through which an alternating current is sent. The core is also set in a bed of refractory clay, held together by steel plates (see

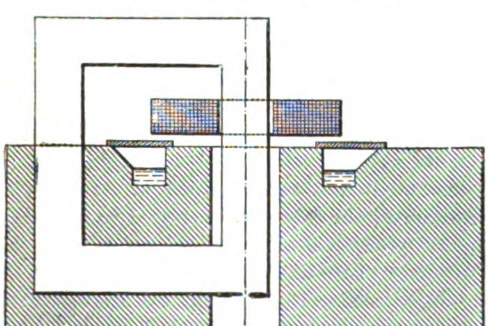

Fig. 27.—Section of an Induction Furnace, showing Annular Channel or Hearth.

Fig. 28), in which is formed a channel also embracing the core, which constitutes the secondary circuit. This channel is covered with lids of refractory material, and the whole furnace can be arranged on trunnions so as to be capable of being tilted to run off melted metal from the channel. Since such an induction furnace cannot reach the high temperature of an arc furnace, it is not adapted for working with impure material, but when charged

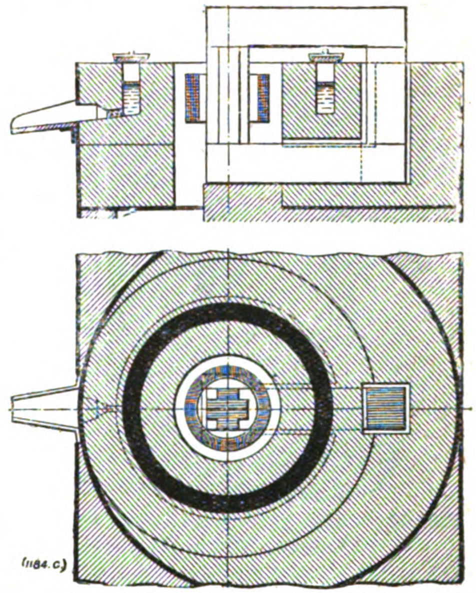

Fig. 28.—Kjellin Induction Furnace.

with a fairly high grade of steel in lumps, these can be melted and refined, freed from occluded gases, and treated with required proportions of ferro-alloys containing nickel, vanadium, chromium, tungsten, and other metals, so as to produce the special steel now so much in demand for tools and machinery of various kinds.

Another well-known induction furnace, introduced by the firm of Hermann Röchling & Co., of Germany, is the so-called Röchling-Rodenhauser furnace, in which induced heating is combined with direct-resistance heating. In the channel which forms the secondary circuit steel plates are inserted to act as electrodes, so that a current from an external source may be passed through the molten metal in addition to the current being induced in it (see Fig. 29 and Fig. 30). This external electromotive force is obtained from an incomplete metallic secondary circuit of copper which terminates in the plates of steel let in or sunk under the refractory lining of the furnace. This lining becomes conductive to a certain degree on being heated to a high temperature and so permits the current generated by the copper secondary circuit to pass through the molten metal. The effect of this is that a larger

hearth can be used, and moreover the metallic secondary circuit reduces the power factor of the furnace so that it attains a higher plant efficiency. Induction furnaces on this plan up to eight or ten tons size at one cast are at work, and are set on trunnions so as to be able to tilt off the slag or charge at pleasure. Induction furnaces have also been constructed which operate with polyphase alternating currents as well as with single phase currents.

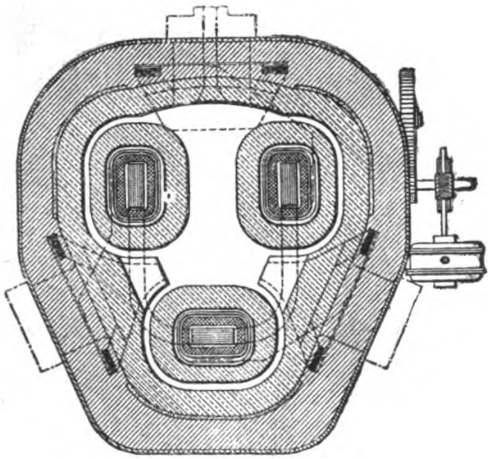

FIG. 29.—RÖCHLING-RODENHAUSER INDUCTION FURNACE. (Three phase.)

The advantages of the induction furnaces are that a high degree of purity can be obtained in the steel produced. They can be constructed up to sizes capable of making a cast of ten tons or more of metal, and owing to the action of the magnetic field in churning up the liquid metal a great uniformity in the quality of each cast can be attained. The first charge is melted by placing steel or iron rings in the channel. These are melted down and form a bath in which the rest of the materials are placed. There is a curious effect called the "Pinch effect," which sometimes makes its appearance in induction furnaces; the liquid or semi-liquid charge draws itself at one place so as to narrow the section, and then an interruption occurs in the circuit with arcing, and the process is repeated.

Another advantage which the induction furnace possesses over the arc type is that the load is more constant and is under better control. In the case of direct-current arc furnaces the rapid variations in the load necessitate the use of special means to control the current.

We may next direct attention to a type of resistance furnace for smaller work in which the material creating the resistance is a granulated high-resistance mixture of carbon and other secret components, suitably named "kryptol." This granulated material is packed round a tube or crucible to be heated, and the current is sent through the kryptol by means of carbon electrodes. The substance

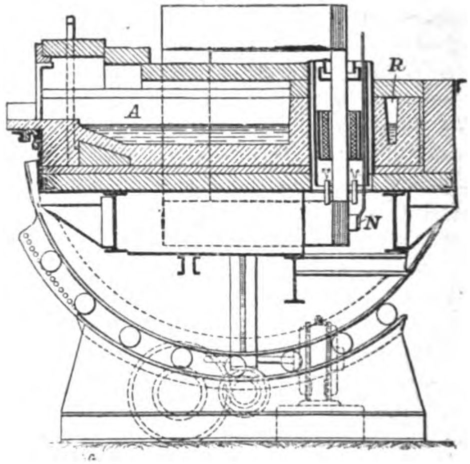

FIG. 30.—SECTION OF A TIPPING INDUCTION FURNACE.

which is to be heated is not therefore in contact with any material to injure it, and the operations take place just as if the tube or crucible were heated by gas. Such furnaces are more useful for chemical laboratory and small metallurgical work than for larger operations in the factory. To the same class belong the very useful laboratory electric furnaces introduced by Heræus. In these porcelain tubes of refractory material are wound outside spirally with platinum foil in strip, and the foil is covered with asbestos and refractory non-conducting material. If a current is passed through the platinum it can quickly be brought up to a temperature a little short of its melting-point (1,750° C.) and maintained for any length of time unaltered, say, at 1,500° C. Hence the interior of the tube can be raised to 1,400° C., or above the melting-point of gold and copper, in a very short time.

Such tubular Heræus furnaces are especially useful for conducting chemical organic combustions in glass tubes, and furnaces of this kind are made for heating crucibles, and also in the form of muffles for metallurgical research. They are supplied in London by Messrs. J. J. Griffin & Sons. The enormous advantage which they have over gas for these purposes is obvious. There are no products of combustion to defile the air and necessitate special means of ventilation, no

external radiation and waste of heat, and no chance of the products of combustion reaching and spoiling the substances under operation. No one who has carried out an organic combustion in a chemical laboratory with an Heræus furnace would ever desire to return even to the best of the gas furnaces used for this purpose. The electric furnace can, of course, be used in any position, and a tube can be heated vertically or at the top only, or in any limited position. Varieties of arc furnace for experimental work have been designed by Moissan, Borchers, and others. One common type consists of a pair of blocks of lime, fireclay or magnesia, hollowed out, so that when put together they form a cavity in which a substance can be exposed to the heat of an electric arc formed between two carbon rods, which are inserted through holes in the blocks and meet in the centre.

When the substance to be heated is not affected by contact with carbon at a high temperature, it may be placed in the hollow crater of the positive carbon, and then exposed to the highest temperature it is possible for us to obtain.

Where such contact with carbon is inadmissible, we can still obtain very high temperatures, exceeding 2,000° C., by passing strong electric currents through tubes of iridium or magnesia, within which the object to be heated is placed.

We have yet to consider the very simplest type of electric furnace, in which there is neither electric arc nor heating circuit, but the heat required is obtained by passing the current through the substance itself.

In nearly all cases the oxides or sulphides of metals are either very bad conductors or even non-conductors at ordinary temperatures; but these substances in most cases become conductors when heated. Whilst rise of temperature diminishes the conductivity of a metal, it increases that of the oxide of the metal. We have an excellent instance of this in the Nernst electric lamp. The oxide of magnesium or magnesia, as also the oxides of the rare metals thorium, yttrium, and so on, are practically non-conductors of electricity at ordinary temperatures. If, however, these oxides, or, better still, mixtures of them, are heated, they become fairly good conductors, and then can be maintained in an incandescent condition by a current sent through them. We have, therefore, only to overcome the initial stage of non-conductivity, and this can be done sometimes without prejudice to the results by mixing a certain proportion of graphite or coke with the oxide or substance. If, then, a current is passed, heat enough is produced by its passage through the carbon to raise the temperature of the mass to a point at which it begins to conduct all through, and the temperature can then be raised to any desired point by increasing the current.

The electric furnace is then reduced to its simplest elements—viz., the electrodes, which are generally carbon, and a mass of the substance operated on. We may even in many cases dispense with any containing vessel, the outer portions of the heap of stuff being heated being sufficient. In the next lecture we shall discuss several important industries which have grown up, based entirely on this simple mode of electrical heating.

On the present occasion I want to devote the remainder of the time to the discussion of some interesting questions with regard to the size and nature of the electrodes. With the exception of the induction furnace, we have in all cases to lead the current into and out of the object to be heated in the furnace by means of electrodes. These electrodes are not merely the avenues by which current or electric energy enters the furnace, they are also avenues by which heat escapes from it. A most important question therefore is the size and nature of these electrodes. Moreover the electrode, no matter what it may be, is a place in which the current is producing heat, and therefore the electrodes themselves dissipate electric energy. If anyone were asked what size the electrodes should be the first reply might be: as thick and short as possible, to avoid waste of electric energy in them. But this reply would have to be corrected, in view of the known fact that all good conductors of electricity are good conductors of heat, and therefore if the electrode is made a good conductor to avoid dissipating electric energy in it, it thereby becomes an easy avenue for the escape of heat from the furnace. Moreover, this escaping heat raises the temperature of the copper conductors conveying the current to the furnace, and thereby also increases the dissipation of energy in them. Hence the problem of the correct size of the electrodes is not to be solved without a careful analysis of the phenomena of the flow of heat and electricity in the electrodes. This analysis has been furnished by Mr. Carl Hering in an interesting series of papers which elucidate the matter admirably. Following him, let us consider the question of the dissipation and flow of energy in an electric furnace electrode or conductor which is insulated perfectly for

heat and electricity over its surface except at the ends. Let us suppose that this electrode is set in a furnace with one end kept at a temperature T (the hot end), and the other end (the cool end) kept at a temperature T_0. Let the length of the electrode be L and its section everywhere the same be S. Then consider a section at a distance x from the cool end, and let this section have a length dx. Let the temperature at the distance x be t, and that at the distance $x + dx$ be $t + dt$, then there is a gradient of temperature dt/dx down the section. Heat therefore flows from the hot end to the cool end of the electrode, and heat is also generated in the electrode by the current. Consider the section of length dx, then if A is the current and ρ the resistivity (taking the mean value), the heat, reckoned in joules, created per second in the section is equal to

$$\frac{A^2\rho\, dx}{S}.$$

Furthermore, heat flows through the section in virtue of the temperature gradient, and this heat, reckoned in joules, is equal to $JkS\frac{dt}{dx}$ where k is the thermal conductivity in calories per square centimetre per second per degree gradient. The heat that flows out of the section on the cool side being denoted by h, the heat that flows into it on the hot side must be less by the amount generated in the section electrically. Let us denote the heat flowing in by $h + dh$, and the heat flowing out by h, then the heat created in the section is

$$h - (h + dh) = -dh,$$

and this must be equal to

$$\frac{A^2\rho}{S}dx.$$

Also the heat flowing out is represented by

$$JkS\frac{dt}{dx}.$$

Accordingly we have

$$-dh = \frac{A^2\rho}{S}dx,$$

and integrating we have

$$-h = \frac{A^2\rho}{S}x + C$$

where C is some constant. Also

$$h = JkS\frac{dt}{dx},$$

hence

$$\frac{dt}{dx} = -\frac{A^2\rho}{JkS^2}x - \frac{C}{JkS}.$$

Integrating again we have

$$t = -\frac{A^2\rho}{JkS^2}\frac{x^2}{2} - \frac{Cx}{JkS} + C^1.$$

Now if $x = {}_0$, $t = T_0$, and hence $C^1 = T_0$. And f $x = L$, $t = T$, and we have

$$C = -\frac{1}{2}\frac{A^2\rho L}{S} - \frac{JkS}{L}(T - T_0).$$

Therefore

$$-h = \frac{A^2\rho}{S}x - \frac{1}{2}\frac{A^2\rho L}{S} - \frac{JkS}{L}(T - T_0).$$

This gives us an expression for the heat passing any section of the electrode per second at a distance x from the cool end. Let $x = 0$, then we have $h = H_0$, and therefore

$$H_0 = \frac{1}{2}\frac{A^2\rho L}{S} + \frac{JkS}{L}(T - T_0),$$

or the heat flowing out at the cool end is equal to the flux of heat due to conduction *plus* half the heat electrically produced in the electrode. If $x = L$, then $h = H$, and we have

$$H = \frac{JkS}{L}(T - T_0) - \frac{1}{2}\frac{A^2\rho L}{S}.$$

For electrodes of given material and for given temperatures of furnace, and given currents, these expressions may be written

$$H_0 = Pd + \frac{Q}{d},$$

$$H = \frac{Q}{d} - Pd,$$

where d is the dimension ratio L/S, and P and Q are constants.

Now it is clear that H_0 or the heat flowing out of the electrode is a function of d, the dimension ratio of the electrode, and H_0 is a minimum when d has such a value that $d = \sqrt{\frac{Q}{P}}$.

Also when this is the case H is zero or *no heat flows into the electrode from the furnace.*

Hence it is always possible to design electrodes for given cases which shall not rob the furnace of any heat or allow heat to pass through them from the furnace.

It will be seen that the ordinates of the curves denoting the variation of H and H_0 with d are the sum or difference of the ordinates of a straight line and an hyperbola, the slope of the straight line being $P = \frac{1}{2}A^2\rho$, and the constant of the hyperbola being $Q = Jk(T - T_0)$.

Hence the value of d or $\frac{L}{S}$, which gives the minimum heat loss, is given by

$$d = \frac{\sqrt{T - T_0}}{A}\cdot\sqrt{\frac{2Jk}{\rho}}.$$

For a given current and temperature fall it depends therefore only on the product of the thermal and the electric conductivity, and that substance will be the most useful for electrodes in which, other requirements being met, this

product is a minimum. Substituting the value of d, which makes the electrode loss a minimum, we find that this minimum loss from the cool end, which we will denote by H'_0, is given by

$$H'_0 = 2\sqrt{P}\sqrt{Q} = A\sqrt{2J}\sqrt{k\rho}\sqrt{T - T_0}.$$

This shows that when the electrodes have had their dimensions so proportioned as to produce the minimum heat loss from the cool ends, that minimum loss is proportional to the current, to the square root of the temperature gradients down them, and to the square root of the ratio of the thermal and electric conductivities. This ratio is very nearly the same for all pure metals, but not identical for non-metals, and for allotropic forms. It is also in pure metals proportional to the absolute temperature. The value of the ratio for carbon and graphite is not very certain, and we are ignorant of the manner in which these values vary with temperature.

In the above simple investigation Mr. Hering* has assumed that the quantities k and ρ are constant, and have values equal to the mean value between temperatures T and T_0. The necessary modifications, when k and ρ are taken as linear functions of temperature, have been made by Dr. A. E. Kennelly, and he has given the correct formulæ for the loss of heat at the cool end and absorption of heat at the hot end of the electrode.

Mr. Hering has made some measurements of the values of the ratio $k/K = k\rho$ for ordinary arc-light carbons and for graphite electrodes. He obtained the following values at about 900° C.

$$\text{Graphite } k/K = k\rho = 0{\cdot}74 \times 0{\cdot}000323 = 239 \times 10^{-6};$$

$$\text{Carbon } k/K = k\rho = 0{\cdot}329 \times 0{\cdot}00148 = 487 \times 10^{-6}.$$

Hence, at this temperature, 900° C., we should have as the values of $\sqrt{k\rho}$ and $\sqrt{k/\rho}$

$$\text{Graphite } \sqrt{k\rho} = 15{\cdot}5 \times 10^{-3}, \ \sqrt{k/\rho} = 48;$$

$$\text{Carbon } \sqrt{k\rho} = 22 \times 10^{-3}, \ \sqrt{k/\rho} = 15.$$

Accordingly, the minimum electrode loss for carbon would be 50 per cent. greater than for graphite. Also for a given length of electrode the graphite electrode could be one-third the section of the carbon. This investigation shows that the size of the electrodes is not a matter of indifference nor the nature of the material selected for them. For a given material it shows that there is a certain dimension ratio (L/S) which gives the minimum heat loss at the electrodes.

It proves also that the notion that graphite electrodes have a disadvantageous thermal conductivity is a fallacy, and it proves in addition that as far as nature of material is concerned that substance is the best for electrodes in which the product of the electric and thermal conductivities is greatest. The practical rule for electrode dimensions is, then, to make the electrodes as short as practical considerations will permit. As the appropriate cross-section will diminish with the length, this makes the bulk, and therefore the cost of the electrode as small as possible. Moreover, the equations show us the importance of producing the required furnace heat with as high a voltage and small a current as possible, and also effecting the required chemical change at the lowest possible temperature or avoiding excessive temperatures.

Much discussion has taken place on the validity of Hering's laws of electrode loss, but there is no doubt that the general principles on which they are based are sound. The modifications which have to be made in his equations when the variation of thermal and electric-resistivity with temperature is taken into consideration are not large, but the electrician who desires further details must be referred to the Papers published in the *Proceedings of the American Institute of Electrical Engineers for* 1909 *and* 1910, entitled "The Laws of Electrode Losses in Electric Furnaces," by C. Hering, "The Proportioning of Electrodes for Furnaces," by C. Hering, and the Paper by Dr. A. E. Kennelly already mentioned.

* See Dr. A. E. Kennelly, "On the Modifications in Hering's Laws of Furnace Electrodes introduced by including Variations in Electric and Thermal Resistivity."—*Proceedings of the American Institute of Electrical Engineers*, 1910.

A PROPOSED LOW-LEVEL TUNNEL AT MONT CENIS.

The advantage of a second tunnel, to relieve the heavy traffic on the Mont Cenis line, is a subject which is receiving considerable attention at the present time in France and Italy.

Opened on September 17th, 1871, the Mont Cenis tunnel was for ten years the only "gateway" by which railway travellers from western Europe could enter Italy. The opening of the two other great Alpine tunnels—viz., the St. Gothard in 1880, and the Simplon in 1906—have to some extent diverted the passenger traffic from the old capital of Piedmont.

The gradients on the approach to the tunnel from the Italian side are very steep, and it is thought that, by constructing a new tunnel at a

lower level than the present one, a considerable saving in the cost of traction could be made.

The new line, proposed by Signor D. Regis, a Turin engineer, would leave the present Turin to Modana railway at the station of St. Antonino, 35 kilometres (21¾ miles) from Turin, and follow the course of the Dora Riparia River on the right bank as far as the little village of Exilles. Here the valley would be crossed by a bridge and viaduct about 700 metres (765 yards) in length, to reach to the southern entrance to the great tunnel, a distance of 31 kilometres (19¼ miles), with gradients not exceeding 20 per 1,000 (1 in 50). The total rise from St. Antonino to this point is 523 metres (1,714 feet).

Piercing the mountain in a north-westerly direction for a length of 22,200 metres (13¾ miles), the tunnel would rise 154 metres (505 feet) to the culminating point, which is fixed at 1,069 metres (3,507 feet) above the sea-level. From this point, which is 226 metres (741 feet) below the greatest altitude in the Mont Cenis tunnel, there will be a fall of 12 metres (40 feet) to the northern entrance, situated about 450 yards from the existing frontier station of Modana, at an altitude of 1,057 metres (3,468 feet) above the sea-level.

The total length of the proposed line and tunnel would be 88½ kilometres, as compared with the 105 kilometres of the existing Mont Cenis route, a saving of about ten miles in favour of the former.

The cost of tunnel and approach line is estimated at 84 millions of lire (£3,360,000), and, if constructed, a saving of about 3,200,000 lire (£128,000) could be effected annually.

The following table gives the altitudes of the proposed tunnel (Exilles — Modana) as compared with those of the three existing Alpine tunnels:—

Name of Tunnel.	Length.		Height above Sea-level.		
	Metres.	Miles.	North Entrance.	Culminating Point.	South End.
			Metres.	Metres.	Metres.
Proposed low-level tunnel (Modana—Exilles)	22,200	13¾	1,057 (3,468 ft.)	1,069 (3,507 ft.)	904 (2,966 ft.)
Mont Cenis (Modana—Bardonnecchia)	12,133	7½	1,160 (3,805 ft.)	1,295 (4,248 ft.)	1,292 (4,239 ft.)
St. Gothard (Göschenen—Airolo)	14,920	9¼	1,109 (3,639 ft.)	1,154 (3,786 ft.)	1,145 (3,756 ft.)
Simplon (Brigue—Iselle)	19,734	12¼	687 (2,255 ft.)	705 (2,312 ft.)	657 (2,155 ft.)

THE SNUFF INDUSTRY OF BAVARIA.

It is in the mountain districts of Germany that snuff-taking is general, and it is in such districts that most of the forest areas of the country are found. In the forests, as a rule, smoking is forbidden, and this may account for snuff-taking superseding tobacco-smoking. A considerable portion of the Bavarian tobacco is made into snuff. There are several factories in Nuremberg that make a specialty of the so-called "Brazil-roll tobacco," made ready to be ground up for snuff, and in Landshut and Regensburg are half a dozen factories having a considerable output of an especially favoured brand of snuff known as "Schmalzler," undoubtedly so named because the main ingredient, after tobacco, is grease (Schmalz). Landshut is the centre of the Schmalzler snuff industry. It is still the custom for the old forest dwellers—that is, the Bavarian highlanders—to prepare their own snuff, which, in the language of the people, is known as "Schmei" or "Schmai," and almost every old snuff-taker has a special recipe of his own. According to the American Consul at Nuremberg, tobacco usually forms not more than half the body of this snuff. The tobacco is the so-called Brazil-rolls. These are formed of tobacco leaves first soaked in a syrup, strongly impregnated with various spices, and then twisted into hard rolls of about one inch and a half in thickness. These rolls can be bought from every village shopkeeper. The old snuff-taker adds to this tobacco, according to individual taste, beef tallow, a little lime, a small pinch of very fine pulverised glass, and such flavouring matter as his experience has found most pleasing. The ingredients are well mixed in a wooden bowl with a wooden pestle, the rubbing process being continued until the required degree of fineness is reached. Pine needles or other similar ingredients are often added as flavouring. The Schmalzler thus finished is usually carried in pouches made from hog's bladder, or in wooden boxes. According to statistics prepared at Passau, to which Landshut belongs, about 220,000 pounds of Schmalzler are consumed in the district annually. The production of the factories at Landshut and Regensburg is somewhat larger, but not very much, for the Schmalzler is largely consumed at home. As tobacco forms about half the bulk of the Schmalzler it follows that something over 110,000 pounds of tobacco are used by these factories annually. A good part of it actually comes from Brazil, where the roll bearing that name was first made, and these factories consume more than half the importation of this class of tobacco. In recent years, however, considerable quantities of Bavarian tobacco have been made into the so-called Brazil-rolls and eventually ground and mixed into the

Schmalzler. In the district about Landshut the habit of snuff-taking is almost universal. The children learn it early, and the women not infrequently contract the habit. Foresters sent there from districts where the habit is not known are said to acquire it very quickly, and its use and the strength of the habit have received official recognition in the instructions to the authorities of prisons and similar institutions in South Bavaria that confirmed snuff-takers must not be suddenly and entirely denied its indulgence.

THE WORLD'S PRODUCTION OF RAW SILK.

The *Union des Marchands de Soie* of Lyons, have published the following statistics respecting the production of raw silk throughout the world during 1910, as compared with that of the previous year:—

	1909 Kilogrammes.	1910
European Countries.		
France	674,000	320,000
Italy	4,251,000	3,947,000
Spain	82,000	83,000
Austria-Hungary	378,000	355,000
Totals	5,385,000	4,705,000
Levant and Central Asia.		
Turkey in Asia—		
Anatolia (Brussa and Ismid)	665,000	510,000
Syria and Cyprus	445,000	515,000
Other Provinces	125,000	100,000
Turkey in Europe—		
Salonica, Adrianople	380,000	285,000
Balkan States—		
Bulgaria, Servia, Roumania	223,000	170,000
Greece and Crete	60,000	55,000
Caucasus	540,000	520,000
Persia and Turkestan (exports)	600,000	540,000
Totals	3,038,000	2,695,000
The East.		
China (exports from Shanghai *)	5,185,000	5,345,000
China (exports from Canton †)	2,295,000	2,500,000
Japan (exports from Yokohama)	8,372,000	8,890,000
India (exports from Calcutta and Bombay)	235,000	215,000
Totals	16,087,000	16,950,000
General Summary.		
European Countries	5,385,000	4,705,000
Levant and Central Asia	3,038,000	2,695,000
Eastern Countries	16,087,000	16,950,000
Totals	24,510,000	24,350,000

* Including Tussah and native-spun silks.

† Including exports to Bombay and other parts of India.

These figures show a considerable falling off in the production of silk in Europe during 1910, as compared with that of the previous year. The decrease is particularly noticeable in France and Italy, in which countries the diseases of the silk-worm and mulberry tree are still so prevalent. On the other hand the East, particularly Japan, holds her own, and even shows a notable increase last year over the production of 1909.

NOTES ON BOOKS.

How to Manage a Suction Gas Producer. By W. A. Tookey. London: Percival Marshall & Co. 1s. net.

This little manual is designed for the use of engineers and attendants placed in charge of suction gas producers. It gives in simple language an account of the starting of a gas producer, the principles involved in gas production, the generator of a suction gas producing plant, the connections between the generator and scrubber, the scrubber and purifying apparatus, and the connections between the scrubber and the engine. A number of simple diagrams illustrate the text, and complete a very practical little handbook well calculated to fill the purpose for which it is intended.

Some Notes on the History of Secondary Education in Jamaica. By Frank Cundall, F.S.A. Kingston: The Institute of Jamaica.

Up to the middle of the nineteenth century the historian of secondary education in Jamaica had little to chronicle but mismanagement and misappropriation of funds; and even to a considerably later period the state of culture in the island appears to have remained somewhat elementary. Of late years, however, considerable improvements have been made. In most of the secondary schools the curriculum is now based on the requirements of the Cambridge University Examination Syndicate. This body has held examinations yearly in the island since 1882, when fifteen candidates sat. In 1898 and 1910 the total reached 328. In 1881 a stimulus was given to secondary education by the institution of the Jamaica scholarships (worth £200 per annum for three years, or £150 per annum for four years, or £120 per annum for five years), tenable at any recognised university or college in the Empire; and in 1904 the first Rhodes scholarship of £300 per annum, tenable at Oxford for three years, was awarded. This scholarship is limited every third year to candidates educated entirely in Jamaica.

The occasion which induced Mr. Cundall to put together these notes is interesting. They were prepared for the information of Mr. H. H. Piggott, H.M. Inspector of Schools, who in the beginning of this year visited Jamaica as a result of the suggestion of the English Board of Education that they

were willing to lend the services of an inspector for inspection work in any colony. Mr. Piggott's visit was the first of its kind paid by a British school inspector to a British colony.

GENERAL NOTES.

Pelagic Sealing.—The Pelagic Sealing Conference, which has been sitting at Washington, has come to the wise decision to suspend pelagic sealing for a period of fifteen years. The pelagic sealers kill the female seals on their way to and from the feeding grounds, and the death of every female so killed means the loss of two more lives to the herd—of the cub left to starve in the rookery, and of the cub as yet unborn. If this were continued, the total extinction of fur seals would soon be brought about. The herd has already been reduced from about two millions in 1882, when regular pelagic sealing began, to 185,000. It is to be hoped that the fifteen years' respite will do much to restore the herd to its former condition.

Forestry on American Railways.—The Pennsylvania Railroad has conducted forestry operations on a large scale for some years past, and according to the report of the company's forester, recently issued, some 4,000,000 trees have been planted in the last nine years, beginning in 1902 with 13,610, and reaching a maximum of 1,054,010 in 1909. The operations cover tracts of land adjacent to various points of the lines east of Pittsburg and Erie, and about thirty-two acres are devoted to nursery purposes at Morrisville, Pa. The company has recently completed two large sleeper and timber-treating plants at Mount Union and Greenwich Point, Pa., which have a combined annual capacity of 1,500,000 sleepers or their equivalent. Although this plant was not put in service until July 1st, 1910, the lumber treated during that year included 671,369 sleepers, 4,500,000 feet of lumber and switch timber, 90,306 paving blocks, and considerable quantities of fence-posts, cross-arms, and poles.

Mineral Production of the Island of Sardinia.—The mineral production of the Island of Sardinia during the year 1909 amounted to 168,481 tons, to the value of 18¼ millions of lire (£780,000). Of this amount zinc figures to the value of 9,200,000 lire (£368,000); lead, 5,400,000 lire (£216,000); lignite, 277,000 lire (£11,080); iron ore, 78,000 lire (£3,120); silver, 68,000 lire (£2,320); manganese, 470,000 lire (£18,800). These amounts, which are considerably below the average for the last ten years, are due to the low prices which have prevailed in the metal market for lead, zinc, and antimony. This has had the effect of stopping, to some extent, the exploration and development of mines throughout the island. The number of workmen employed in this industry was 12,487, being 1,238 less than the average for the preceding nine years.

The Hemp or "Chingma" Industry in China.—Chingma, which means a light-green hemp, is cultivated to a considerable extent in the Tientsin district, in the Pei-ho Valley, along the Grand Canal, and in the region to the north and west of Pekin. The methods of preparing the fibre for market are very primitive. The leaves are stripped from the stalks by hand, and are used for a number of purposes. The fibre is contained in the outer rind or bark of the stalk, as is the case with flax, and is submitted to a process analogous to the retting of flax. The stalks, bound in bundles, are submerged in water, generally in a stagnant pool, and mud from the bottom is piled over them to keep them covered. After time has elapsed to allow the vegetable gum which holds the fibres together, and to the inner stalk, to decay, the stalks are stripped of the fibre by the latter being drawn by hand over the teeth of a rude iron comb, fixed to a heavy plank. This combing is all the preparation it gets. It is then made up into bundles for the market. The inner stalks, which are very white, are used for fuel. Large quantities of the fibre are exported from Tientsin.

Electrolytic Steel.—The manufacture of electrolytic steel seems to be progressing in Norway. Two new companies have just been formed, and made a beginning with building operations. The Stavanger Staalverk Aktieselskab has a capital of 450,000 kronen, and has entered into an agreement with one of the power companies to take 2,500 horse-power annually, the price fixed being between 20 kronen and 25 kronen per horse-power year. The intention is to erect one electric furnace, a rolling and hammering plant, and a foundry, the productive capacity being 1,400 tons of rolled steel, 300 tons of hammered steel, 600 tons of cast steel, and 700 tons of waste. The second works is being erected by a small company formed in 1896, the capital being increased to 2,200,000 kronen. Electric power is to be got from Böilefos Falls, Nidelven, and a steel plant is to be built near Arendal. As with the Stavanger Company, the electric furnace to be employed is that of the Swedish Electrometal Company. The estimated output is 14,500 tons annually.

Decrease of Horses.—According to the returns issued by the Board of Agriculture for 1910, the total number of horses in Great Britain used for agricultural purposes (including mares kept for breeding and unbroken horses) was 1,545,376, or 7,617 fewer than in 1909. The total number of cattle of all kinds returned in 1910 was 7,037,327. Since 1905, when the number of horses reached 1,572,433, there has been a steady decrease at the rate of 13,000 a year. In the census years of 1871 and 1881 there were on the farms of Great Britain 48 horses for every 1,000 of population. In 1891 the number was 45, 41 in 1901, while in 1910 the proportion of horses was only 38 to every 1,000 of the estimated population.

Journal of the Royal Society of Arts.

No. 3,061. VOL. LIX.

FRIDAY, JULY 21, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

PRESENTATION OF THE SOCIETY'S ALBERT MEDAL TO THE HON. SIR CHARLES PARSONS.

The Council of the Royal Society of Arts attended at Clarence House on Friday, the 14th inst., when His Royal Highness the Duke of Connaught, K.G., President of the Society, presented its Albert Medal to the Hon. Sir Charles Algernon Parsons, K.C.B., LL.D., D.Sc., F.R.S., "for his experimental researches into the laws governing the efficient action of steam in engines of the turbine type, and for his invention of the re-action type of steam turbine and its practical application to the generation of electricity and other purposes."

The members of the Council present were :—Lord Sanderson, G.C.B. (Chairman), George Ranken Askwith, C.B., K.C., Sir Steuart Colvin Bayley, G.C.S.I., C.I.E., Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., Henry Taylor Bovey, LL.D., F.R.S., Lord Blyth, Dugald Clerk, F.R.S., Alan Summerly Cole, C.B., Hon. Sir Charles W. Fremantle, K.C.B., Robert Kaye Gray, Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., Sir John Cameron Lamb, C.B., C.M.G., Sir William Lee-Warner, G.C.S.I., William Henry Maw, M.Inst.C.E., Hon. Richard Clere Parsons, M.A., Sir Westby B. Perceval, K.C.M.G., Sir Boverton Redwood, Bart., D.Sc., F.R.S.E., Sir Owen Roberts, M.A., D.C.L., Carmichael Thomas, Sir Philip Watts, K.C.B., LL.D., D.Sc., F.R.S., Colonel Sir John Smith Young, C.V.O., with Sir Henry Trueman Wood, M.A. (Secretary), and G. K. Menzies, M.A. (Assistant Secretary).

SHIPLEY'S TOMB.

It was mentioned in the Annual Report* that the Council had defrayed the cost of renovating the tombstone of William Shipley, the originator of the Society, who died at Maidstone in 1803, and was buried in All Saints' Churchyard there. Mr. J. H. Allchin, the Curator of the Maidstone Museum, has kindly furnished the Secretary with a transcript of the inscription on the stone, which was formerly illegible. It reads as follows :

To the Memory of
WILLIAM SHIPLEY ESQ.
late of this Town,
whose Public Spirit
gave rise to the Society
established in London,
for the Encouragement
of Arts, Manufactures,
and Commerce,
Ob[t] 28[th] December
1803, Æt. 89.
Also of M[rs] ELIZ[th] SHIPLEY,
his widow,
Ob[t] 13[th] August
1806, Æt. 76.

On the south side of the tomb is the following inscription :

ELIZABETH SHIPLEY,
died March the 8[th] 1769,
Aged 2 Months.

It may be noted that the inscription does not absolutely settle the doubt referred to in the *Journal* of June 9th (p. 769, footnote), as to the precise date of Shipley's birth, though it appears to make it certain that he was born either in 1714 (the accepted date, perhaps taken from the tombstone), or in 1715 (which appears more probable). *Ætate* is a little vague, and might equally well be used of a man who was over 89, or in his 89th year.

* See *Journal*, Vol. LIX., p. 823, June 30th, 1911.

PRACTICAL EXAMINATIONS IN MUSIC.

The Practical Examinations in Music were not concluded this year until the 10th inst., too late for the results to be included in the Report of the Council. They lasted for seven days.

The examinations were conducted by Dr. Ernest Walker, M.A., and Mr. Burnham Horner.

The system of examination was the same as that for recent years. For instrumental music certain standards are given, and candidates are asked to select for themselves which of these standards they choose to be examined in. The standards range from easy to very difficult music. For each standard a list of music is given for study, and from this list candidates select the pieces they will sing or play. Candidates are expected to play or sing the pieces which they have prepared, to play or sing a piece, or portion of a piece, at sight, and to play certain scales.

In all, 289 candidates entered, and of these 283 were examined, a decrease of 56 as compared with last year. There were 214 passes and 69 failures.

The following were the subjects taken up:— Piano, singing, violin and violoncello. 239 entered for the piano, 182 of whom passed; 37 entered for the violin, of whom 28 passed; 4 entered for the violoncello, 3 of whom passed; 8 entered for singing, of whom only 1 passed. One medal was awarded.

The quality of the competitors was, on the whole, much the same as usual, though that of the junior pianists was perhaps slightly better than last year. A good many failed through attempting standards too high for their present attainments; and there were often signs, among the pianists, of insufficient attention to details of touch and phrasing. The best work was among the violinists, some of whom showed great promise.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE APPLICATIONS OF ELECTRIC HEATING.

By Professor J. A. Fleming, M.A., D.Sc., F.R.S., M.Inst.E.E.,

Pender Professor of Electrical Engineering in the University of London.

Lecture III.—Delivered March 20th, 1911.

The Technical Applications of Electric Heating.

We shall, in the present lecture, consider some of the most important of the technical applications of electric heating and products of electric furnaces. There are whole manufactures which have been entirely created of late years by the possibilities of electric heating, and other fields in which it is proving a valuable auxiliary to ordinary combustion heating. Let us discuss first some of the cases in which resistance-heating is employed in its simplest form—viz., in which the material to be operated upon is itself the resistance by which the heat is produced. One of the most striking of these is the manufacture of *carborundum*, which has attained considerable proportions in the United States at Niagara Falls.

Carborundum is a carbide of silicon produced by heating sand, sawdust, and coke to a temperature of 1,950° C., or near the melting point of iridium. At that temperature a reaction takes place in accordance with the chemical equation:

$$Si\,O_2 + 3\,C = 2\,CO + Si\,C.$$

At a higher temperature still, about 2,250° C., the carbide of silicon is dissociated and the carbon deposited in the form of graphite. Carborundum so made presents itself in bluish crystals having a specific gravity of 3·12 and a hardness approaching that of the diamond. This substance was produced first by Mr. E. G. Acheson in 1891, during an attempt to make diamonds artificially. It is now manufactured at the rate of 3,000 tons or more a year at Niagara Falls by currents generated in the Falls power-house. Owing to its great hardness it is found to be an excellent substitute for emery, and is enormously used in the production of grinding-wheels of all kinds and polishing powders. A small but interesting use of it is as a receiver in wireless telegraphy, owing to the unilateral conductivity possessed by the crystal. It is made by passing a powerful current through a mass of finely-powdered coke sawdust and sand in proper proportions. This mixture is stacked in rectangular furnaces built

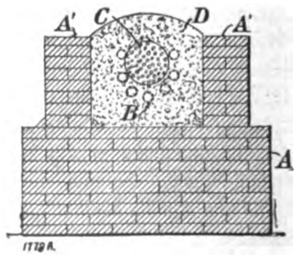

Fig. 31.—Section of Acheson Carborundum Furnace, showing the Coke Core, C, and Charge, D.

of loose bricks about 16 × 7 × 6 feet in size, through the ends of which massive electrodes of carbon are thrust to convey the heating current into the mass. A core of granulated coke is laid along the centre from electrode to electrode to start the heating (see Fig. 31).

The current through the mass increases as the temperature rises, and finally remains steady at about 7,500 amperes when supplied at 100 volts, the power taken being therefore 1,000 h.-p.

The carbonic oxide produced by the reaction escapes through the bricks, and is allowed to burn on the outside. The process of cooking a charge takes twenty-four hours, at the end of which time the structure is dismantled and the contents sorted out. The 1,000 h.-p. furnace yields about four tons of carborundum per diem, and there is also a by-product of graphite from the coke core. The carborundum works at Niagara produce about seven to ten tons per day, using 3,000 h.-p., delivered as electric current from Niagara Falls.

Closely connected with this is another large manufacture started by Mr. Acheson, in which *graphite* is prepared in various forms from coke and coal. Graphite, also called plumbago or blacklead, is one of the allotropic forms of carbon, and both the other varieties of carbon—viz., diamond and charcoal—are converted into graphite at a high temperature. Graphite is characterised by a higher electric conductivity, by marking paper, and by resistance to ordinary chemical reagents. Hence, it has enormous uses in the manufacture of electrodes for electric furnaces, crucibles and other things. Moreover, owing to its smooth, greasy nature, it is largely used as a lubricant in various forms. It occurs native as plumbago, in which form it is used for making lead pencils, but many mines are now becoming exhausted. Acheson devised a process of making it electrically from anthracite coal. This coal is powdered and stacked in a rectangular brick furnace similar to those used in carborundum manufacture (see Fig. 32). A core of coke is built in connecting the

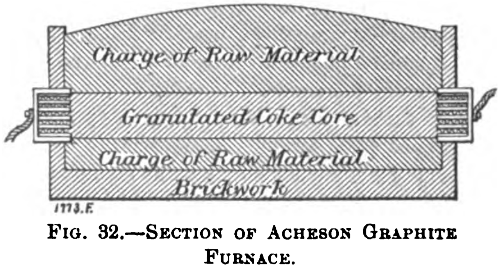

Fig. 32.—Section of Acheson Graphite Furnace.

massive carbon electrodes and the current is then turned on. The process of conversion is not simply a thermal one, but the silica in the coal probably plays an important part, a carbide of silicon (carborundum) being first formed in the interior and then broken up at a higher temperature with deposition of the carbon as graphite as the temperature rises. In this manner the same silicon is used over and over again, as it makes its way from within outwards. The result is that the coal is finally transformed into graphite. Over 2,000 tons per annum are now produced at the Acheson graphite works at Niagara Falls. Acheson has recently discovered methods for producing not only a hard form of graphite for electrodes, but soft oleaginous graphite with which a whole series of oily lubricants are manufactured.

In connection with the above manufactures, which are carried on at Niagara Falls, mention should be made of aluminium production, for though this is partly an electrolytic operation, yet electric resistance heating enters into the process. The problem of profitably extracting metallic aluminium from the earth's strata, which contain it, was for long an unsolved enigma. Oxide of aluminium or alumina forms a large part, some 17 to 20 per cent. of the sedimentary terrestrial crust, but the oxygen is so firmly held by the aluminium that it cannot be reduced by heating with carbon, as is the case with oxides of the most common metals. After several processes had been tried and abandoned, the practical solution was arrived at almost simultaneously in America and in France by two young chemists—Hall and Héroult—when both were hardly more than students. It is as follows:—The mineral cryolite is a double fluoride of aluminium and sodium, and is fusible at a good red heat. The substance called fluorspar, or blue john, is a fluoride of calcium, and is also fusible. If the cryolite and fluorspar are mixed in certain proportions and melted, the liquid will dissolve alumina. The alumina used in manufacture is prepared from Irish bauxite, which is a crude oxide of aluminium, containing also silicates and iron. The hydrated alumina is extracted from the bauxite and rendered anhydrous. A mixture of cryolite, fluorspar and pure anhydrous alumina is then placed in an iron crucible lined with carbon and heated. When fluid a graphite electrode is dipped into it and a current sent through the fluid, which heats it and keeps it liquid (see Fig. 33). Also if the graphite is the anode, the liquid is electrolysed and metallic aluminium is deposited at the bottom of the crucible. The success of the process depends on the fact that the reduced aluminium has a greater density than the fused salts, and hence falls to the bottom of the pot, and is drawn off at

intervals by a tap. The process is continuous. If the voltage per pot does not exceed five or six volts the alumina alone is electrolysed and not the cryolite or fluorspar. Hence it is only necessary to add fresh alumina from time to time, and to draw off the deposited aluminium. Of the energy of the current about half is absorbed in keeping the contents of the crucible liquid—viz., at 850°–900° C., and the remainder in effecting the reduction of the oxide.

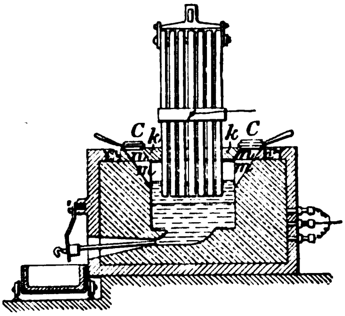

FIG. 33.—SECTION OF ALUMINA REDUCTION POT.

This Hall-Héroult process is now carried out on a large scale at Niagara Falls, U.S.A., at Neuhausen, on the Falls of the Rhine in Switzerland, and at the Falls of the Foyers on Loch Ness, and at Loch Leven in Scotland, by the British Aluminium Company, where 30,000 h.-p. are being so used. The electric current required is generated by dynamos driven by water-turbines by the falls, and is led through a number of the electrolytic pots in series. Each pot takes a current of about 7,000 to 10,000 amperes at five volts or 50 k.w., and the number of pots worked in series depends on the electromotive force of the current. At Niagara Falls each pot takes up 65 h.-p., and produces 112 lb. of aluminium per day.

As an illustration of the enormous development of the industry, Mr. Kershaw mentions, in his excellent book on electro-metallurgy that in 1886 the total production of aluminium in the world was only three tons and the price £2 16*s.* per lb. In 1906 it had risen to 12,000 tons, and the price had fallen to 1*s.* 10*d.* per lb. The total cost of production of aluminium by this Hall-Héroult process is about 1*s.* per lb., but not an inconsiderable fraction is the cost of the preliminary preparation of the pure alumina. The possibility of cheapening the production of aluminium depends almost entirely on improvements in cheapening the production of the pure anhydrous alumina, or else in using the crude bauxite itself directly in the furnace. It is needless to refer to the ever-increasing uses of aluminium in the arts. It has become a rival to copper as an electric conductor, and in combination with other metals furnishes alloys of great utility.

As a final example of this mode of electric resistance heating the manufacture of calcium carbide may be mentioned. Calcium carbide, $Ca\,C_2$, is a compound of calcium and carbon, which is prepared by heating lime and coke intensely in an electric furnace. Potassium carbide was first produced by Sir H. Davy in 1808, and calcium carbide by his cousin, Robert Davy, in 1836, and re-discovered by Wöhler in 1862, and again by Moissan and Willson in 1892. The reaction which takes place is represented by the equation

$$Ca\,O + 3\,C = Ca\,C_2 + CO.$$

When calcium carbide is acted upon by water the inflammable gas acetylene is produced

$$Ca\,C_2 + 2\,H_2\,O = Ca\,H_2\,O_2 + C_2\,H_2.$$

Acetylene is now much used for the production of lighting gas. More recently calcium carbide has found another field of work in the preparation of calcium cyanamide, now used as a fertiliser. The manufacture of calcium carbide is conducted on a large scale at Odda, in Norway, where 23,000 h.-p. are taken from the River Tysse, and partly thus used for the preparation of nitrate fertilisers. The calcium carbide is crushed, and nitrogen gas prepared from liquid air is passed over the carbide at a high temperature. The two substances combine with the production of calcium cyanamide. This material is used as a fertiliser, and when placed in the soil and acted on by water, supplies the nitrogen necessary for the growth of vegetable food-stuffs in the form of ammonia.

During last year the total production of calcium carbide in the whole world for acetylene gas production amounted to nearly 240,000 tons, whilst some 15,000 tons were used for the production of cyanamide. At Odda about 20,000 tons of carbide were made for lighting purposes and about 4,000 for the manufacture of cyanamide. In fact, we may say that the manufacture of calcium carbide is one of the most important of the electro-thermal industries at the present moment.

Before leaving, however, the discussion of those manufactures which involve pure resistance heating, we may refer to the application of electric heating, of increasing importance in connection with the manufacture of ordinary and of quartz glass. Ordinary glass is a mixture of silicates of various bases—soda, lime and

oxide of lead, and the materials are heated in a furnace to the melting-point generally by producer gas. The glass so made softens at or below a red heat, and owing to its relatively large expansion with rise of temperature is easily cracked if heated unequally. The application of electric heating to ordinary glass-making has not yet made great advance, owing chiefly to the great economy of the regenerative gas furnace, but for special kinds of glass it is found that advantage is gained by heating the pots by packing them round with kryptol, through which a current is sent. An entirely new manufacture has been developed of late years in the production of pure quartz glass. Quartz is nearly pure silica, but melts only at a temperature of 1,800° C. to 2,000° C. Moreover, quartz has a very small coefficient of expansion, and a quartz article can be heated red hot and plunged into water without cracking.

A mass of homogeneous quartz can be prepared by a process due to Messrs. Day and Shepherd. Fragments of quartz are placed in a thin-walled graphite box, which is included in an air-tight steel vessel. The graphite box is heated electrically up to a temperature of about 2,000° by passing a current through it. The quartz is melted and partly volatilised. The air is displaced from between the fragments, a considerable air pressure, 500 lb. per square inch, is then applied, and the temperature of the quartz kept at 1,800° C. for some time. On cooling the quartz fragments are found to have become a homogeneous mass. Quartz can be worked like glass in the oxyhydrogen blowpipe and fused electrically, and chemical vessels of all kinds are now made with it, which have great advantages over glass.

A very striking example of the utility and importance of electrical heating is to be found in the comparatively modern industry of producing ferro-alloys. Of late years metallurgists have discovered the great effect which small percentages of chromium, nickel, manganese, vanadium and tungsten, either separately or together, produce on the physical properties of iron and steel, and the preparation of alloys of iron with these metals as well as with non-metals, such as silicon, is now a prosperous manufacture, carried on chiefly in France, Germany, and America.

Metallurgists distinguish steels as binary, ternary, quartenary, according as they contain two, three, four, etc., elements. Ordinary steel is a binary, and consists of an alloy of iron with certain carbides of iron. If, however, a small proportion of chromium, vanadium, tungsten, or nickel is added to the molten steel before casting, the resulting properties of the metal are quite different from those of ordinary carbon steel. Very striking results as to tensile strength, hardness, and resistance to shock are obtained from low carbon quarternary steels containing these metals, and these steels are much used for motor-car axles, for armour-piercing projectiles, for high-speed tools for metal turning, and numerous other purposes. As the amount of the third or fourth element is extremely small, 1 or 2 per cent., or less, and must be uniformly diffused, it is found it can best be imparted by putting into the carbon-steel, when in a molten condition, a certain proportion of an alloy of iron having in it a large known percentage of the special metal.

The manufacture of these ferro-alloys is now carried on at places where water-power is abundant and available for the production of electric current for use in electric furnaces.

One of the largest of these is in France, in the Haute Savoie, where the Girod Electrometallurgical Company is using 18,000 h.-p. for the production of ferro-silicon, ferro-tungsten, ferro-molybdenum and ferro-vanadium, the output being 9,000 to 10,000 tons per annum, valued at £360,000. The type of electric furnace in which these alloys are prepared is illustrated by the views shown of the Girod, Héroult and Keller electric furnaces.

One of the alloys most in demand is ferro-silicon, an alloy of iron with 10, 20, 50, or 80 per cent. of silicon. This alloy is used to bestow hardness and fluidity in cast-iron, by adding a certain proportion of it to the molten iron just before casting; 5,000 or 6,000 tons of it are produced per annum at the Girod works alone.

Another important alloy is ferro-tungsten. It is employed in the production of high-speed tool steel, which does not soften even at a red heat, and can, therefore, be used for making cutting tools, which cut much faster than ordinary carbon-steel and effect an enormous saving of time in engineering shops. The demand for this steel has greatly increased since 1900, when the Bethlehem Steel Company's exhibit at the Paris Exhibition drew attention to this subject. Over one half of the ferro-tungsten made is used in Sheffield.

The manufacture of these ferro-alloys is at present being conducted in France by MM. Keller, Leleux et Cie, at Livet and at Kerrousse, and also by the French Electro-

metallurgical Company, at La Praz and St. Michel, and, as already mentioned, by the Girod Electrometallurgical Company at Ugine. In Colorado, U.S.A., a large works has recently been erected for the production of ferro-vanadium.

At Livet and Kerrousse the Keller electric furnace is employed. The materials for making the alloys, iron or steel, scrap ores or oxides of the special metals, coke and fluxes, are charged into the towers and then heated by a very strong current. The heat is produced partly by resistance and partly by arc. The liquid alloy collects in the lateral channel of the furnace, and is tapped off at intervals. At La Praz and St. Michel the Héroult arc furnace is employed, and at Ugine the Girod furnace. There is a great demand for ferro-silicon containing various large percentages of silicon for use as a deoxidising agent. Ferro-chrome is largely used in armour-plate manufacture to bestow hardness, whilst ferro-vanadium has been found of the greatest use in bestowing power of withstanding shock in steels employed in axles, shafts, and gears of motor-cars. At first difficulty was experienced in obtaining ferro-alloys sufficiently free from carbon, but by the use of pure raw materials, avoiding over-heating, and by the prevention of contact between the electrodes and the charge, or by the use of induction furnaces, these difficulties have been overcome, and the carbon contents have now been reduced to about 2 per cent. It is for this reason that resistance or induction furnaces are most advantageous in the preparation of ferro-alloys.

As regards the products of these factories, they are chiefly ferro-chrome for hardening steel, ferro-tungsten for producing high-speed steel, ferro-silicon for general foundry work.

Steels containing from 7 to 22 per cent. of chromium are very hard and resist shock, whilst a small addition of vanadium, 0·2 to 0·8 per cent., gives great toughness as well and ability to withstand vibration. Another alloy steel which has a high value is molybdenum-chromium-steel, employed in making armour-piercing shells, on account of its great hardness and toughness. The special qualities of these steels will, however, be best discussed after describing their mode of preparation. The application of the electric furnace in the manufacture of iron and steel has opened a new chapter in the history of one of the leading industries of the world.

For the sake of those who are not metallurgists it may be well to sketch in outline the older processes for the production of iron and steel, in order that the novelty introduced by electric heating may be better understood. Iron occurs in nature in the form of impure oxides or carbonates. The purest ore is *magnetite*, or magnetic oxide of iron (Fe_3O_4), which is widely distributed in the earth's crust. Much of the best Swedish iron is made from this ore. Magnetite contains about 70 per cent. of pure iron.

The ore known as *hæmatite*, red or brown, is a ferric oxide, anhydrous or hydrated, but the chief source of iron in Great Britain is the abundant clay ironstone, which is an impure ferrous carbonate containing 30 to 33 per cent. of pure iron and found with the coal measures in Staffordshire, South Wales, and likewise in places in Central Europe.

The preparation of iron from the clay ironstone involves the following processes. The ore is broken up and roasted to expel water and carbonic dioxide and leaves a crude oxide of iron as the result, mingled with silica, aluminic silicates and magnesia and oxide of manganese, also some phosphates. The ore is then treated in the blast furnace, being heated in a blast of hot air when mixed with coke and lime. Pure iron is only fusible at about 1,500° C., but if carbon is present, then the melting-point, in accordance with the usual rule, is lowered. Molten iron also dissolves carbon very readily. Accordingly the process of reducing the iron ore consists in heating it with carbon in the form of coke. The carbon combines with the oxygen, forming carbonic oxide and dioxide, and with the iron forming a carbide of iron, whilst carbon is also dissolved by it as well. The lime is necessary to act as a flux, and it combines with the silica and alumina to form an easily fusible slag. The lime also removes sulphur and phosphorus to some extent. The carbon in the resulting metal varies from 3½ to 6 per cent. The product of the blast furnace when run off into moulds is known as cast-iron or pig-iron. There are three varieties of it called respectively, *grey*, *mottled* and *white* cast-iron. The white cast-iron contains the same percentage of carbon as the grey or mottled, but the greater part of it appears to be chemically combined with the iron, whereas in the other two uncombined carbon is distributed throughout the mass. The grey cast-iron is preferred for casting, and is that variety produced when the blast furnace is in good working order. To obtain the very high temperature required for the reduction of

the ore a large quantity of air has to be forced through the blast furnace, but by the regenerative methods now in use the heat from these escaping gases is utilised to heat the incoming blast.

It has been found possible to produce 1 ton of pig-iron by the use of 16 cwt. of coke, but as 6·5 cwt. out of this are required to reduce the oxide to the metallic state, only 9·5 cwt. are used to produce the high temperature. The problem of producing pig-iron from ore electrically is, therefore, reduced to the possibility of heating a mass of iron ore, lime, and coke to the required temperature by the passage of a current to bring about the above-described reduction. This can be done in the Keller and other forms of electric furnace, but unless the electrical power can be obtained extremely cheaply, or unless the price of coal is very high, the electrical production of pig-iron does not seem able yet to compete with the combustion process. Hundreds of tons of pig-iron have, however, been prepared in the Keller furnace electrically. To produce 2,000 lbs. of pig-iron from ore charged cold into the electric furnace appears from experience at Niagara Falls to require 2,500 kilowatt-hours of electrical energy. If the ore is heated first the expenditure can be reduced to 2,000 kilowatt-hours. Even if we take the cost of the kilowatt-hour as low as ¼*d.*, it is clear that the electric-power cost will be £2 1*s.* 8*d.* per 2,000 lbs. of pig, which is in excess of the cost of the 10 cwt. of coke which could be saved, taking prices which rule in Great Britain and many other countries.

Cast-iron or pig-iron may be regarded as the raw material for the production of iron in the forms in which it is required in modern engineering. The excess of carbon, especially the uncombined carbon, in the pig gives it brittleness and want of tensile strength, which render it unfit for many purposes. This excess can, however, be removed, and gives us the material in the form of wrought-iron or steel. It would occupy far too much time to enter into a full discussion of the constitution of the iron-carbon compounds. Suffice it to say that wrought-iron is, or should be, nearly pure iron with very small admixture of carbon, sulphur, phosphorus, silicon and manganese, the iron amounting to 99 per cent. or over. It has a fibrous structure, is soft, and can be welded, and has a high melting point, near 1,500° C. The substance known as carbon-steel consists of a solid admixture or alloy of a carbide of iron with iron. This carbide has the composition Fe_3C, and is called *cementite*, the pure iron being known as *ferrite*. The amount of carbon may vary from 0·3 to 1·57 per cent., according to the mode of production. Steel may in a sense, therefore, be said to be the connecting link between wrought-iron or pure iron and cast-iron. Steel, however, differs strikingly from wrought or cast-iron, in that many grades of it can be hardened by quenching suddenly when at a high temperature. It then becomes so hard that it will scratch glass. If the hard steel is heated to a certain point, and slowly cooled or annealed, it becomes elastic. In annealed steel the carbide of iron appears to be distributed throughout the mass in little aggregations. If, however, the steel is heated, this carbide is dissolved, and becomes diffused through the iron. Quenching or cooling suddenly prevents the carbide from aggregating itself, and the solid uniform admixture of carbide of iron in iron is extremely hard. The hardness of steel is a result, therefore, of the formation in it of more or less of this constituent. If the steel is then slowly heated again after quenching, the constituents undergo rearrangement and the separation of the carbide, or its aggregation, again takes place, and is accompanied by a softening of the metal as the martensite disappears. It is this property of possessing a large range of hardness, combined with its elasticity and tensile strength, which gives steel its engineering value. Hence the production of steel consists in giving to, or leaving in, the iron just enough carbon to form the requisite quantity of active carbide without any excess. Steel can, therefore, be made in a variety of ways. It may be done by adding the proper quantity of carbon to pure or wrought-iron; or it can be made by taking away from cast-iron a part of the carbon. Steel can also be made directly from pure oxides of iron or ore. In carrying out the first method pig-iron, as made in the blast furnace, is first refined by melting it and exposing it to a current of air by which it is partly oxidised, and this oxide of iron then gives up oxygen to the carbon in the form of carbonic oxide, which escapes from the molten mass. If oxide of iron in the form of iron scale is added and the mass stirred in proportion as the carbon is oxidised, this mass becomes less fusible. It is finally withdrawn from the puddling furnace, and by hammering and rolling compressed into bars of so-called wrought or worked iron. To convert it into steel, carbon must be imparted to it in certain proportions. This was formerly done by heating

the iron bars with carbon in a furnace for several weeks. The process called cementation converted the iron into steel, at least on the outer portions. A more homogeneous material was then obtained by melting these steel bars in a crucible and casting it in the form of *cast steel.* Bessemer invented the process of depriving cast-iron of its carbon by blowing air through it, and then adding to the deoxidised iron just enough carbon in the form of a highly carburetted iron to convert it into steel.

Since steel presents us with a wide range of properties in the finished material, and with greater toughness and less brittleness than cast-iron, and greater tenacity and less plasticity than wrought-iron, practically the whole of the iron required in engineering is required or used in the form of steel. The great problem of iron metallurgy is therefore the production of steel in the various qualities required for engineering work. Again, since the discovery of the enormous influence of small amounts of special metals on the qualities of the resulting steel, the manufacture of ternary and quarternary steel has assumed a most important aspect.

The problem before the iron and steel manufacturer in England is to produce as quickly and cheaply as possible a material from our British iron ores which can be converted into steel. Owing to the proximity of the clay ironstone deposits to the coal measures in Great Britain, and to the exhaustive attention which has been given to the theory and practice of the blast furnace, the possibilities for employing electric heating in the manufacture of pig or cast-iron are not large, since the margin for economy is very small. In countries where coal is dear and water-power abundant, the case is different, and the electric production of pig-iron may have a future. On the other hand, it has now been recognised that in the production of steel, and especially of high-grade compound steels, the electric furnace is destined to play a most important part in the present and future of steel manufacture. In making steel the crude cast-iron has not only to be deprived of the excess of carbon, but also of sulphur and phosphorus, and the silicon and manganese reduced below certain values. Also the steel has to be prevented from taking up and occluding gases. It is well known that most bars of steel when put into a vacuum give out nitrogen, which has been absorbed in the manufacture.

In the ordinary furnace processes of making steel in the Siemens-Martin open-hearth furnaces the steel is exposed to the products of combustion. If there is an excess of air—that is, if the flame is kept in an oxidising state—there is unnecessary loss of iron, and it is impossible to free the steel from absorbed gases. On the other hand, if the flame is kept reducing it is difficult to obtain a high enough temperature. These difficulties are overcome by electric heating. The temperature can be raised to a sufficiently high value to get rid of occluded gases. The carbon can be removed by the addition of iron oxide, and the metal can also be freed almost completely from the sulphur and phosphorus by appropriate fluxes.

The electric furnace is well adapted therefore for the manufacture of case-hardening steels as the action of air can be avoided and a sound homogeneous metal obtained without excessive additions of silicon and manganese.

At the present time the great use of the electric furnace is in the production of steel direct from pig-iron and scrap. The process when using an arc-resistance furnace of the Héroult or Girod type is as follows:—

A charge of pig-iron and scrap-iron is laid on the hearth and iron ore (oxide of iron) and lime added in calculated amount to produce a slag. The current is then turned on and the charge melted by combined arc and resistance heating, and the melted slag then prevents further oxidation. The decarbonisation of the iron and its purification from sulphur and phosphorus is then assisted by turning on an air-blast, as in the case of a Bessemer converter. When the iron is sufficiently refined a known and calculated amount of carbon is added in the form of a carburite or highly-carbonised iron, and the resulting steel is tipped into the casting ladle. According to details given by Mr. J. B. C. Kershaw (see *Electrometallurgy*), one Héroult furnace at La Praz produces six tons of steel per day in two heats of three tons each, using 4,000 amperes at 120 volts. The resulting product contains only ·003 per cent. of phosphorus and ·007 per cent. of sulphur, whilst the carbon and silicon can be varied at pleasure by adding carburite or ferro-silicon at the end of the operation. Single electric furnaces are now, however, in operation turning out 200 tons of steel per day for the last sixteen months. In the electric furnace almost any degree of refining can be carried out, as the sulphur and phosphorus can be almost completely removed and the quality of the electric-made steel is better than that of material of similar composition made in an oxidising furnace. It appears that scrap-iron can be economically

refined and converted into good steel by the expenditure of about 700 to 800 kilowatt-hours, or kelvins, per ton in a Héroult furnace.

In the case of special steels in which various ferro-alloys have to be added at the final stage, and when the right carbon contents have to be carefully maintained, the induction furnaces present great advantages in enabling the whole process from start to cast to be under most accurate control. The manufacture of these special steels is becoming every year more important. Moreover, there are certain qualities which can be best obtained by electric-made steels, such as power of resistance to shock. Engineers are in the habit of testing steels by ascertaining the stress in tons per square inch which must be applied before the steel bar undergoes a permanent strain. This is called the elastic circuit. Also the contraction in area at this point, and the breaking strain and contraction in area at rupture are measured. These figures, however, give us only what may be called the static qualities. Steel as used for rails, wheels, axles, and machinery generally, suffers severe vibration, and it is, therefore, now customary to apply a test of its dynamic qualities or resistance to shock by ascertaining what number of times a bar of steel can be rocked backwards and forwards by rapid shocks or blows before rupture.

Certain elements introduced into carbon-steel have an enormous effect in increasing its static and dynamic qualities. Thus, for example, vanadium in quite small percentages acts like magic. The following are some figures taken from a research by Professor Arnold, of Sheffield. Thus a bar of Swedish iron had an elastic limit of 26,800 lbs., and contraction in area of 50 per cent. When alloyed with 0·85 per cent. of vanadium its elastic limit rose to 45,120 lbs., and contraction in area to 72 per cent. Here we have a striking improvement in elasticity, resilience, and ductility produced by less than 1 per cent. of a foreign element. Again, the effect on carbon steel is equally marked. Taking steel with 1·1 per cent. carbon in it and adding increasing percentages of vanadium the elastic limit and contraction in area varied, as shown in Table I.

Hence, the best result seems to be obtained by 0·58 per cent. of vanadium. In an excellent article on vanadium steel in *Cassier's Magazine* for June, 1910, Mr. W. E. Gibbs gave some astonishing figures as showing the superiority of vanadium steel to ordinary steel. Two pieces of steel, one ordinary carbon steel the other

TABLE I.

Per cent. of vanadium.	Elastic limit in lbs. per sq. inch.	Contraction in area in per cent.
0·00	67,000	7
0·14	96,120	6·9
0·29	99,320	10
0·58	144,800	7·6
0·77	131,300	9·3
1·11	120,600	17·6

vanadium steel, 4 in. long and ⅜ in. square, were fixed at one end and the free end vibrated by shock ¼ in. each way. The tempered carbon steel broke after forty movements, the annealed carbon steel after 250, the annealed vanadium steel after 500 vibrations.

The best steel for moving machinery is a chrome-vanadium steel, and at present has no superior for motor-car axles and crankshafts, as shown by the following figures:—

TABLE II.

Steel sample.	Elastic limit in lbs. per square inch.	Contraction of area in per cent.	No. of alternating shocks to fracture.
Carbon Axle .	41,330	61	960
Nickel Axle .	49,270	58	800
Vanadium Axle . .	63,570	61	2,700
Vanadium Crankshaft	110,100	58	1,850
Vanadium Gear . .	224,000	39	800

The vanadium can be introduced into the steel before casting in the form of a ferro-alloy. Although vanadium itself is a very infusible metal, yet its alloy with iron in the proportion of 1 : 2 melts at 1,400° C.

It may be an advantage to give by way of conclusion some figures as to the cost of producing steel from scrap-iron by certain of the types of electric furnace described in the previous lecture. Taking, for instance, the Girod 2-ton arc-resistance furnace, charged cold with scrap-iron and turnings, the cost of melting a ton of steel has been found to be as follows:—

	£	s.	d.
2 cwt. of lime, 2 cwt. of iron ore . . .	0	2	6
Added alloys	0	4	0
Electrodes	0	4	9
Labour . . . . } Upkeep of furnace, wear and tear. . . }	0	12	0
Power 1,000 kilowatt-hours, say at ¼d. per kilowatt-hour	1	0	10
	£2	4	1

Exclusive of cost of scrap.

If the furnace is charged with liquid steel from a converter or Siemens furnace, and the electrical process is a mere refinement, then the cost would be reduced to :—

	s.	d.
¾ cwt. lime and additions	1	7
Electrodes	1	7
Labour	2	5
Furnace upkeep	4	0
Power 300 kilowatt-hours, say at ¼d. per kilowatt-hour	6	3
	15	10

The prime cost of such a furnace is about £340, together with £120 for fittings, regulator and leads. A 400 h.-p. dynamo is required, the cost of which will be about £590, exclusive of engine or driving power. Hence we may say that the electrical plant for a 2-ton furnace will cost rather above £1,000.

Some details as to cost of working a Röchling-Rodenhauser induction furnace have been given in a paper by Mr. J. Harden (see *The Electrician*, March 18th, 1910). The furnace was charged with a basic Bessemer steel taken hot from the converter, having the composition, C = 0·3, S = 0·07 to 0·08, P = 0·06 to 0·07 per cent., and was refined in the induction furnace so as to finish with a composition C = 0·14, Si = 0·01, Mn = 0·41, S = 0·032, P = trace per cent. The weight of the finished ingot was 7,000 kilograms, and the materials and alloys used were as follows :—

	s.	d.
Lime, 550 kilogrammes, at 10s. per ton	5	6
Roll Mill Scale, 30 kilogrammes at 13s. per ton	0	4
Ferro-Silicon (50 per cent.), 30 kilogrammes at 200s. per ton	6	0
Ferro-Manganese (80 per cent.), 20 kilogrammes at 180s. per ton	3	6
	15	4
Per 1,000 kilogrammes	2	2½
Power consumed, 1,381 kilowatt-hours = 197 kilowatt-hours per ton at ¼d. per kilowatt	4	2
Lining of furnace	0	10
Labour	2	0
Cost per 1,000 kilogrammes = 1 metric ton	9	2½

Hence for something less than 10s. per ton, this basic steel was converted into a high-class steel suitable for tubes of marine boilers.

In large steel and iron works the electric power required can be obtained from blast furnace gases and gas-engines at a very low cost.

Those who desire to follow up this brief sketch of the technical applications of electric heating may be referred to the following books :—

"Electrometallugry," by Mr. J. B. C. Kershaw.

"The Electric Furnace in Iron and Steel Production," by Mr. J. B. C. Kershaw.

"Electric Steel Refining," by Mr. D. F. Campbell.

The Electrician, October 7th, 1910, p. 1056.

"The Electric Furnace," by Mr. J. Harden.

The Electrician, March 18th, 1910, p. 921.

"Electric Furnaces and Their Industrial Applications," by J. Wright. (Constable & Co.)

THE POPULATION OF THE EMPIRE.

In a paper read recently before the Royal Statistical Society, Sir J. Athelstane Baines, C.S.I., gave some interesting results of an attempt to analyse the expansion of the Empire in area and population during the Victorian Era.

He took 1841 as the starting-point, not for historical reasons only, but also because shortly before that date there appeared the first methodical review of British possessions abroad, including a careful estimate of the population of each unit at the time. Of course, the information available regarding the population of many of the colonies is very defective up to 1871, and is even now a matter of estimate only, so that recourse must be had in such cases to computation upon the best data available.

"Accuracy being thus qualified," said Sir J. Athelstane Baines, "the population in question increased between 1841 and 1911 from 203,221,000 to 418,735,000, or by 106 per cent. The first point is to distinguish between the growth of population upon existing territories, and the increase due to the acquisition of new possessions. The population of the Empire of 1841, then, expanded, according to my estimate, by 68·2 per cent. The balance of the increase, amounting to 37·8 per cent., is to be credited to territory added since that date. Here again, however, the element of growth comes in as the acquisition took place at different intervals; and, so far as I can see, 10·5 per cent. out of the 37·8 per cent. increase occurred since the territories became part of the Empire. We can, therefore, set down the growth at 159,971,000, and the accretion by annexation at 55,543,000, or 78·7 per cent. of the one, and 27·3 of the other.

"The area has naturally not expanded in proportion to the population, and to the 8,526,641 square miles of 1841 the addition has been but 2,804,602, or 32·9 per cent. Starting with 24 persons per square mile, the ratio increased steadily to 36 in 1891, when a check to the growth of population in India, and the incorporation of large areas of sparsely-peopled territory in Africa reduced the proportion to 35, which recovered by

the end of the period to 37. Thus, whilst the population has doubled, the pressure upon the land has increased by but little over one half.

"Leaving on one side for the present the newly-acquired possessions, the rate of growth of the population of 1841 has been slow, considering the large area of thinly-peopled land available. In India, the seventy years added 58 to every 100 inhabitants of 1841, or 10 less than the general rate; and the United Kingdom, with a diminishing Irish community, acquired but 69, or 1 above the average. Far higher is the rate in the New World, especially in Australasia, which could scarcely be called peopled up to 1851. South Africa, too, seems to have multiplied its inhabitants tenfold; but, until the last ten years or so, Canada, with a relatively higher, yet still very sparse population, showed a remarkable lagging in covering its vast field of habitable territory, and was not, indeed, far in advance of the comparatively long-settled Ceylon. On the whole, if from the territories of 1841 we subtract India and this kingdom, the rate of growth will be raised from 68 per cent. to 467. By the year 1871 it had produced 281 for every 100 persons thirty years before, whilst the Empire of 1841 as a whole could only show 126; and this lead increased as years went on.

"We can thus appreciate the position occupied by India and the United Kingdom in relation to the enormous aggregate population of the Empire, as now constituted, an aggregate which has been estimated to amount to a quarter of the whole population of the earth. India alone contained about 85 per cent. of the British subjects of 1841, and even now, in spite of the more rapid growth of other countries, it accounts for no less than three-quarters. Taken together with this country it left, in 1841, only a little over 2 per cent. in the rest, a proportion which now stands at 14 per cent. The specific population, too, or the number of persons per square mile, is similarly affected by the exclusion of these two countries, as they are the only two, with the exception of the smaller territories of Ceylon and the West Indies, which support more than 100 to the mile. In the rest of the Empire, including the two last-mentioned units, the corresponding number was only 0·58 in 1841, 2·67 in 1891, and 6·20 according to the latest estimate. Putting the case in absolute, instead of proportional, numbers, the population of the Empire outside India and this kingdom in 1841 was about 4,500,000; in 1885 it was 15,000,000 and a little over; but by the end of the period with which I am dealing it had risen to 58,500,000."

A SILICA STANDARD OF LENGTH.*

The general properties of fused silica, and in particular its remarkably low coefficient of expansion, render this substance specially suitable for the construction of permanent length-standards of the highest class.

The coefficient of expansion of platinum-iridium, which has hitherto been the material almost exclusively employed in the best work, is about 9×10^{-6} per degree C., while that of silica over the ordinary range is about $0{\cdot}4 \times 10^{-6}$, *i.e.*, 1/20 of this amount. It is true that the best qualities of invar, M. Guillaume's nickel-steel, containing 36 per cent. Ni, have expansion coefficients comparable with that of silica, but experience has shown that while invar is eminently useful for working standards, it is quite unsuitable for primary standards, owing to its large thermal hysteresis. Fused silica, on the contrary, has been found to be practically free from this defect; it enjoys, in the matter of cost, an enormous advantage over platinum-iridium; furthermore, in view of the fact that primary standards are always handled by trained and skilled observers, its comparative fragility is of small consequence.

Modern methods of manufacturing and working silica have rendered it possible to construct a silica line-standard metre. The present model, the first of its kind, consists of a silica tube into which are fused at its ends optically-worked plane parallel slabs of silica. These carry the graduations, and their undersides are platinized. The graduations, defining the metre length, are made by cutting through the platinum film with a ruling diamond. The platinum deposit permits the ruling of very beautiful clean-edged lines.

The bar is supported at the Airy points so that the slabs are horizontal. The lines are viewed from above through the slabs, and are thus seen to advantage.

The apparent length of the standard is independent of any change of tilt of the cover-slips which are used to protect the platinum films. The thickness and position of the end slabs are so arranged that the image of each reference line lies in the "neutral plane" when the bar is immersed in water.

The silica metre was annealed at about 450° C., and shrank a little over half a micron in the process. It is anticipated that its future secular variation will be negligible so far as practice is concerned.

* By Dr. G. W. C. Kaye. Communicated to the Royal Society by Dr. R. T. Glazebrook, F.R.S.

THE BOARD OF EDUCATION EXAMINATIONS IN ART.

In a circular addressed to local education authorities and schools of art it is announced that the Board of Education intend in the near future to terminate the elementary examinations in art now conducted by them, and to substitute examinations of a more comprehensive character adapted to the needs of students who have reached a fairly advanced level in their studies, and who may reasonably desire to have their individual

progress tested in some such way as is open to students of other subjects by means of the various external examinations conducted by universities and other bodies. The examinations on the present lines will therefore not be indefinitely continued, and a new scheme of examinations, of which the details have not yet been announced, will be brought into force in 1913. It is proposed to invite some teachers in schools of art to assist in the conduct of these examinations.

Similarly, the existing series of tests for art class teachers' and art masters' certificates will be brought to an end in 1912, and new regulations will be issued for the award in 1913 and subsequently of qualifying certificates for teachers of art, upon conditions which will secure, in addition to high artistic attainments, the advantages of a general education and of a suitable course of professional training at some institution recognised by the Board for the purpose.

The merits and defects of the national competition have been the subject of much discussion in recent years, and the Board are satisfied that it may be capable of becoming more useful than at present for the purpose of affording an opportunity to the public of seeing the best work of which the most advanced students of schools of art are capable. They propose therefore to invite some experienced head-masters of schools of art and others to consult with them as to the lines upon which a reformed competition can best be established. If a satisfactory scheme can be framed, the Board will arrange a suitable place for the exhibition.

It is also hoped at an early date to effect some readjustment of the various scholarships and exhibitions for students of art which are now awarded or aided by the Board, so as to secure liberal opportunities of obtaining advanced instruction in art to intending teachers and other students throughout the country. In this connection, the Board give notice that the award of local free studentships will be made for the last time in 1911, for tenure during 1911-12, and that the award of local scholarships in art and the aid given to local exhibitions in art may not be continued, or may be continued under new conditions, after 1911, as may be necessary for the purposes of the readjustment contemplated.

Finally, the Board propose to constitute for a term of three years from September 1st, 1911, a standing committee of advice for education in art, upon which their officers will have the assistance of eminent artists, including those appointed as professional examiners for the new examinations and as visitors to the Royal College of Art, of teachers in schools of art, and of manufacturers and others engaged in the industries most dependent upon art. It will be the first duty of this committee to assist the Board in working out the detailed schemes which will be necessary in order to carry out the changes foreshadowed in the circular.

THE BRAZILIAN TOBACCO INDUSTRY.

Nearly two hundred years ago the Colonial Government at Bahia interested itself in the economic situation affecting the growth and marketing of tobacco, and from that time its production has been of great importance in Brazil, and has in some districts been almost the entire source of income to the inhabitants. As early as 1796 the exportation of tobacco from Bahia to Portugal had attained considerable proportions. The exports from that colony, later a province, increased regularly until the close of the monarchical period in Brazilian history. At the time of the establishment of the Republic the advantage of regularly-organised labour was lost to tobacco producers, and the annual production has, on the average, remained almost stationary since that time. At present, tobacco forms the sixth item in importance on the list of Brazilian exports. Of the total exports of tobacco from Brazil, about 95 per cent. is shipped from the port of Bahia, the next largest amount being from Porto Alegre. Over 92 per cent. of the exports are purchased by Germany, Argentina taking most of the balance. The State of Bahia has, since colonial times, been the centre of the tobacco industry of Brazil. Practically all the coast regions of this State produce tobacco to a greater or less extent. In fact, most of the coast regions from the State of Maranhao south have tobacco-producing districts of varying importance. The area of greatest production is a comparatively small section of the State of Bahia, centring about the bay and port of that name. Of late years a somewhat intensified cultivation has been developed in Rio Grande do Sul, and in southern Minas Geraes. There is also a district of somewhat heavy production in eastern and southern Pernambuco. The State of Bahia, according to the United States Consul-General at Rio de Janeiro, exports to other parts of Brazil an average of about 3,000 tons of tobacco per annum, in addition to an average of 22,500, or perhaps 25,000, tons sent abroad. Manufactures of tobacco in the shape of cigars, cigarettes, and pipe tobacco, shipped from Bahia to other Brazilian ports, amount to about £100,000 annually. Probably the second most important areas producing tobacco are in the State of Minas Geraes. Shipments of leaf, and what is called roll tobacco, prepared for pipe and cigarette smoking, from that State amount to about 3,500 tons annually. One of the distinctive forms in which tobacco from that State is prepared, is that of a long roll of very dark and compact leaf which is sold retail at so much a yard. The cigarette smokers in the interior whittle off the necessary amount from the end of such a roll for cigarettes. Rio Grande do Sul has some tobacco-producing areas, which are fast becoming second only to those of Bahia. There is also a notable increase in the attention given to the cultivation of tobacco in the State of Santa Catharina. In Sao Paulo the industry has become decadent with the growth of the coffee industry. While there are no

available figures covering the total production of tobacco in Brazil with any accuracy, it is estimated that this production is about 36,500 tons annually. Experts in Brazilian agriculture unite in affirming that methods of growing tobacco, gathering the crop and curing it, have changed little, if at all, since the days of the early colonists two centuries ago. Practically nowhere is there any idea of tilling the soil and cultivating the crop with an instrument more modern than the spade. As a consequence, very few planters cultivate more than what is known in the language of the country as a "terefa," an area about equal to four acres. It is stated that well-fertilised land in the better districts of Bahia will, under existing conditions of culture, produce a maximum of 800 pounds per acre, but the average production is not much, if any, above 300 pounds per acre. In many districts from Bahia northward, tobacco is planted in any soil which will not produce sugar-cane or cotton. In the best tobacco-producing areas in the Bahia district the soil is black, heavy, and usually very rich, formed of limestone. In the States of Alagoas and Sergipe, just north of Bahia, the best tobacco and also sugar-cane soils are of a similar character. In the latter States, and in the tobacco-producing areas northward, a light, sandy soil is also considerably devoted to tobacco, as is also the case in Minas Geraes. It is generally accepted that with the exception of two or three varieties of island tobacco grown in New Caledonia, practically all known varieties of tobacco are grown in Brazil. Among others, there are a large number of varieties indigenous to the country. In the south of Brazil a variety very common is the *Nicotiana alata* and the *N. Suaveolens*. A variety very common in the hotter regions is called the *Nicotiana chinensis*, cultivated also in Cuba and Porto Rico. Practically all the varieties grown in Maryland, Virginia, and Cuba are common in Brazil. The tobacco produced is used for all purposes, that of Bahia only being suitable for really good cigars. Many of the cigars manufactured in Bahia compare, it is said, favourably with medium-grade Havana cigars. The greater part of the tobacco is strong, though some very good mild tobacco is grown in Bahia, and of late in Rio Grande do Sul. In Bahia planting begins in March and extends throughout May, the plants being started in hotbeds and set out in from one to two months. In the south, planting does not begin until the opening of the hot season in November. When the plant begins to leaf the lower buds are cut in such a way as to cause the stock to branch. The tobacco cut from the main stock is considered of first quality, and that cut from the branches of second and inferior grade. The plant is not allowed to bloom, but is topped in most regions, the leaves being cut as they ripen. In the curing of the crop the general rule is to air-dry the leaves in sheds, but in practice the leaves are frequently allowed to lie for a long time on the ground, and even exposed to wet weather for some time before being cared for. There is no doubt that Brazil offers a great opportunity for tobacco production, and when scientific and modern agricultural methods have been more generally adopted, the country will be a much greater factor in the world's tobacco trade than it is at present.

HOME INDUSTRIES.

The Transport Trade Strike.—The seamen and firemen who commenced the transport trade strike have been much more successful than it was generally expected, not without reason, they would be. Increased wages were their principal desire, and these were conceded by leading steamship companies with hardly the semblance of resistance. The benefits secured are largely due to the demand being made upon a favourable market, and not as the result of a strong organisation—which was notoriously lacking—on the part of the workmen concerned. Whether, in the absence of such an organisation, the men will be able to retain what they have won remains to be seen. So far as the seamen and firemen are concerned, the strike would have ended almost as soon as it began but for the fact that much larger bodies of dockers and carters had made it impossible for the business of the shipowners to be carried on until an agreement had been arrived at with them also. The seamen and firemen have secured a present rise of 10*s*. in wages; besides concessions in the matters of medical examination, representation, and other subsidiary matters, together with recognition of their Union. Substantial benefits also accrue to the carters. The men have not got all they set out to get, but they have obtained considerable financial benefits, and the conditions of employment in many of the grades will be greatly improved. It may be hoped that things will now go on smoothly in the shipping industry, but the settlement does not, of course, touch the admitted shortage of British seamen, which is compelling shipowners to employ Asiatics, or to lay up some of their ships. Upon this point a suggestion has been made that seems to deserve consideration. It is that the Board of Trade might consider whether the time has not come when it might wisely relax some of the restrictions imposed on the shipment of seamen, and, so far as they are harmless, restore to some extent the facilities which formerly existed. For instance, years ago it was the custom of many owners to secure a supply of the very best type of seamen from the fishing districts. During the off seasons fishermen were only too willing to go a voyage or two in steamers so as to fill up their time, and shipowners used to secure these men through local agents. The Board of Trade, however, made it a penal offence for anyone to supply seamen unless they received a licence from the Board. The object of the legislation was ostensibly to put down crimping, and it was never intended to apply to cases such as are referred to above. The effect of the legislation was, however, to stop the supply of fishermen, as licences were refused,

and to increase shipowners' difficulties in securing the best type of men. It seems a little absurd that in engaging seamen an owner cannot be represented by a responsible agent.

The Bradford Woolcombers and the Auctions.—The strike among the woolcombers at Bradford is over, and work has been resumed on the old conditions. A prolongation of the strike must have seriously affected values at the London auctions. At the auctions held last week, prices did not fall quite so much as was generally expected. No class of wool was more than 5 per cent. down, except New Zealand slipes, which fell about 7½ per cent. Stocks and raw material at Bradford are heavy, and it is hardly to be expected that the opening rates will be maintained throughout the auctions. Instead of there being any shortage of supplies, they are much heavier than was expected, and some Bradford merchants and brokers have been asked to take off the market a sufficient quantity of New Zealand crossbreds to prevent any serious fall in values, but this would be a very doubtful experiment. Notwithstanding that during the present year consumption has been at a maximum, the carry-forward from one auction to another has gradually increased, until it has reached nearly 40,000 bales, and the bulk of the new clip is almost due. On the other hand, the demand for goods both at home and abroad, is slackening. The shipments from Australia for the wool year 1910-11, which ended on June 30th, are put at 1,975,000 bales, or an increase of 54,000 bales, compared with the previous season, whilst from New Zealand the shipments amounted to 493,000 bales, a decrease of 20,000 bales.

The Cotton Supply.—Messrs. Neill Brothers have issued a circular on the position of the cotton supply, in which they say that, in the matter of distribution, the noteworthy feature is the extreme smallness of the exports to Great Britain, which have only amounted to 22,000 bales for the whole period, against 119,000 last year. The visible supply for Great Britain, it is pointed out, is now only 72,000 bales above that of last year, though early in March the excess was 400,000 bales. "After this date last year America still exported 100,000 bales to Great Britain. This year practically nothing is coming, and it is only too probable that the supply of American cotton in this country will dwindle to a dangerously low point between now and about October 10th, which is the date when the smallest Liverpool stock usually occurs." Messrs. Neill's comparative estimate of the world's consumption of American cotton for the season is as follows:—

	1910-11.	1909-10.
Great Britain	3,050,000	2,750,000
Continent	4,300,000	4,375,000
U.S. North and Canada	2,400,000	2,450,000
,, South (takings)	2,350,000	2,342,000
Japan, Mexico, etc. (takings)	150,000	115,000
Total to be consumed at mills	12,250,000	12,032,000

Messrs. Neill think, however, that their estimates for Great Britain may be too small. As to the new crop, they speak of it as very hopeful, but it must be remembered that there are two months of the hot season still to reckon with, to say nothing of the subsequent dangers and vicissitudes.

The Silk Trade Dispute.—A section of the Macclesfield operatives are threatening to strike unless their demands are conceded, and should work be stopped, dyers, weavers, soft silk winders, warpers, and others, will soon be idle for want of material, and the whole of the industry in the town may be brought to a standstill. The demands of the men include (1) increased wages; and (2) the abolition of the bounty system—a small extra payment made to workers who get through a given quantity of work in the week—the contention being that this system does not give them more than an average addition to their money of 3*d.* a week. The women's wages at present range from 10*s.* a week for winders and cleaners, to 12*s.* for danters and 12*s.* 6*d.* for parters. They ask for an advance of 1*s.* a week all round. The men are paid as follows:—Single spinners (mostly youths) 14*s.* a week, double spinners 16*s.* 6*d.* a week, and throwsters £1 a week. In their case a rise of 2*s.* a week is demanded.

The Insurance Bill and Spinners.—Mr. J. M. Thomas, who is a member of the Parliamentary Committee of the Federation of Master Cotton Spinners' Associations, makes out a strong case for his contention that the contributions proposed to be levied both upon the spinner and the operative are out of all proportion to the sickness benefits which the operatives are likely to receive under the Bill. Mr. Thomas gives two typical instances:—Firm No. 1.—Employs 301 males and 142 females. The combined contributions from operatives and employer amount to £616 9*s.* 2*d.* per year of fifty weeks. Taking the experience of illness at this mill, which amounts to, at the outside, not more than three females and two males per week, or, put in another way, is equivalent to three females and two males being absent for a whole year of fifty-two weeks, the sickness benefit received by such five persons would be £110 10*s.*, or less than 18 per cent. of the combined contributions. Firm No. 2.—Employs 143 males and 64 females. Contributions paid would be £288 10*s.* The sickness experience at this mill is not more than one person per week, and the benefits received, assuming the sick person was always a male, would be £26 per year, or less than 9 per cent. of the combined contributions. The total sickness benefit likely to be received in accordance with the past experience at these two mills is about £136. A contribution of ½*d.* each per week from the employer and operative would realise £130.

The Insurance Bill and Women.—A large number of representative women have issued a letter in which they contend that the Insurance

Bill, if passed into law in anything like its original form, will inflict great injustice upon women. For instance:—A domestic servant enters service at fifteen and marries at thirty-five a small shopkeeper. After marriage she devotes herself to her household duties and perhaps to the management of the shop. She thereupon ceases to be "employed" within the meaning of the Act, and is not allowed to continue even as a voluntary contributor (C. 34) (4). If she predeceases her husband she never gets any advantage for the twenty years' contribution she made before marriage. If she survives her husband and supports herself by the shop or by some kind of jobbing labour she can only benefit under the Bill by becoming a voluntary contributor, in which case she will have very much reduced benefits compared to the employed contributors. Compare with this the treatment of the male worker under C. 71. He at sixty is entitled to receive repayment of the amount by which his contributions have exceeded the unemployed benefit received by him. Again, no person who is receiving board and lodging from an employer is to get any sickness or disablement benefit (C. 8) (7). This will hit the domestic servant class very hard. At the last census there were upwards of two million female servants in the United Kingdom. There is no security in the Bill that women shall be admitted to approved societies. There is nothing to prevent any of the existing societies adopting a sex disqualification, and under the bill this may be the prudent thing for them to do. It is noticeable that approved societies are precluded from adopting an age disqualification (C. 24). There are many other provisions of the Bill to which women not unnaturally object. The points indicated above suggest that their grievances in relation to it are substantial, and in some respects the Chancellor of the Exchequer has expressed his readiness to meet them.

NOTES ON BOOKS.

The Essentials of a Country House. By R. A. Briggs, F.R.I.B.A. London: B. T. Batsford. 7*s*. 6*d*. net.

Mr. Briggs has had very considerable experience in the building of country houses, and he has already published at least three volumes dealing with bungalows, cottages, and country residences. In the present book, under the heading "Essentials," he treats of a great variety of subjects, such as situation, aspect and soil, plan, porches and vestibules, halls and staircases, the various rooms, doors, windows, fittings, stables, garages, lodges, gardens, etc. The text is illustrated entirely from photographs and plans of houses erected from his designs and under his own supervision, at costs ranging from £1,250 to £4,600. Many of the illustrations are exceedingly pleasing, but they would have gained in variety had they not all been taken from the same source. Mr. Briggs, in spite of some annoying little mannerisms of style—as, for instance, his habit of addressing the reader as "dear madam"—has much sound and sensible advice to offer, and his book should, as he hopes, prove useful in helping those who intend to build to come to some definite conclusions before they consult an architect.

Whittaker's Arithmetic of Electrical Engineering. Second Edition. London: Whittaker & Co. 1*s*. net.

This little book contains 72 worked examples and 300 graduated exercises, a large number of which have been taken from the City and Guilds of London Institute examinations in electric lighting and power transmission, and telegraphy and telephony, and from the Board of Education examinations in electricity and magnetism. It forms one of Messrs. Whittaker & Co.'s well-known series of Handbooks for Electrical Engineers, and will be much appreciated by the technical students for whose use it is intended.

GENERAL NOTES.

The Iron and Steel Institute.—Arrangements have been made to hold the autumn meeting of the Iron and Steel Institute at Turin on Monday and Tuesday, October 2nd and 3rd, 1911. The provisional list of papers expected to be submitted for reading is as follows:—(1) "Report on the Mineral Resources of Italy," by various authors. (2) "On the Autogenous Welding of Metals," by Dr. Francesco Carnevali (Turin). (3) "On the Application of Electrical Energy to the Manufacture of Iron and Steel in Italy," by Cav. Ing. Remo Catani. (4) "On the Present State of the Iron and Steel Industries of Italy," by Signor Comm. Luigi Dompé and Cav. Francesco Saverio Pucci. (5) "On New Industrial Processes for the Cementation of Steel," by Cav. Professor Dr. Federico Giolitti. (6) "On Cementation with Gas under Pressure," by Professor Dr. F. Giolitti and Dr. Francesco Carnevali. (7) "On the Transformation of Steel within the Limits of Temperature employed for Heat Treatment," by Louis Grenet (Argenteuil, France). (8) "On Basic Slag," by V. Adolphe Kroll, jun. (Frankfurt-am-Main). (9) "On the Use of Titanium in Iron and Steel," by C. V. Slocum (Pittsburg). (10) "On the Physico-Chemical Properties of Slags," by Professor J. H. L. Vogt (Christiania).

Co-operative Dairies in Italy.—Co-operative dairies originated from the necessity of using milk for industrial purposes. They had their origin in the mountains and first developed there, where property is much divided and association becomes indispensable if a profit is to be made on the milk. In the fourteenth and fifteenth centuries, in several Alpine valleys, the milk was brought together and

subjected to the necessary treatment in common. This is the most ancient form of rural co-operation. The first phase was the system "turnario famigliare," or the reciprocal loan of milk. After that they passed to the system "turnario sociale," and only in more recent days is found the real joint enterprise, in which each member merely consigns his milk to the association which sells the common produce. In the first system the milk is treated successively in the houses of each associate. In Italy this system is still followed by the co-operative dairies of Osoppo, where the rearing of the cows and the whole treatment of the milk is done exclusively by women. In the system "turnario sociale" the milk is treated in a depôt possessed in common, the plant and utensils being also in common, under the management of a "casaro" (cheesemaker) appointed by the group of associates. Only a few years ago this type was common to nearly all the co-operative dairies of Upper Venetia.

The American Tinplate Industry.—It appears from an examination of the monthly trade returns of the United States that during the first ten months of the fiscal year 1911 (July 1910-April 1911) both the tin imports and the tinplate exports of the United States exceeded all previous records for a similar period. The total imports of pig-tin, of which England and the Straits Settlements are the chief sources of supply, amounted in the ten months ending with April 1911 to 92,374,000 pounds (compared with 86,464,000 pounds in the same months of the preceding fiscal period), valued at £6,963,000. The exports of tin and terne plates in the ten elapsed months of the current fiscal year aggregated 50,370,000 pounds (compared with 21,183,000 pounds in the corresponding period of 1910), valued at £373,000. The production of tin and terne plates in the United States in the calendar year 1909, the latest for which statistics are available, was 1,371,000,000 pounds, the largest total for any year in the history of American production, and as the importation of pig-tin for use in this line of manufacture was larger in the calendar year 1910 than in 1909, and is also larger in the accumulated months of the fiscal year 1911 than in the same months of the fiscal year 1910, it may be assumed that the production of tinplate in the United States is still increasing. Canada is the chief market for the tinplate exported to foreign countries, but large and growing shipments are now being made to Alaska and Hawaii, for use in their canning industries.

Automobile Engineering Apprenticeship Scheme.—A committee of the Incorporated Institution of Automobile Engineers has been collecting information from many large motor-car manufacturers and others as to the practice in vogue in their works with regard to the admission and instruction of pupils and apprentices. This information has now been tabulated, and will be placed at the disposal of parents seeking advice on the subject, for which purpose application should be made to the Secretary at 13, Queen Anne's Gate, Westminster, London, S.W., by letter in the first instance. It is hoped that by this means parents will be saved a great deal of trouble and anxiety, and possible expense, by being placed in a position to have access to information extending over a very much wider area than they could obtain by their own unaided efforts, and it is also hoped that through the Institution the various works will be brought into contact with those youths who are likely to show themselves specially apt in the branch of the industry in which they are to be placed.

International Shipping and Oil Engine Exhibition.—An International Shipping and Oil Engine Exhibition is to be held in Newcastle-on-Tyne in November next, when it is expected that a large collection of the most highly-developed types of oil engines will be brought together. Oil engines are being with increasing frequency installed on large vessels, and huge oil engines are at present being built for the navies of various Powers.

The Scarcity of Meerschaum.—The valuable material from which meerschaum pipes are made is continually getting scarcer, and the important industry which has flourished in Vienna, Budapest, Nuremberg, Paris, and in the Thuringian town of Ruhla seems endangered. The manufacture of meerschaum pipes is much more important than is generally supposed. The town of Ruhla alone has been exporting, in round figures, pipes to the value of about £350,000 annually. The finest grade of meerschaum is found near Eski-Shehr, in Anatolia, Asia Minor, in a hollow which, in early days, was a lake, in which the meerschaum was precipitated. Meerschaum is also found in other places, including Thebes, the Bosnian mountains in the neighbourhood of Grubschitz and Nuendorff in Moravia, and in some parts of Spain and Portugal.

Number of Students at Paris University.—The total number of students at the University of Paris last year was 17,708, divided as follows:—

Law	7,871
Medicine	3,756
Pharmacy	871
Literature	3,310
Science	1,900

In the Faculty of Medicine there were 3,330 male and 426 female students, and as regards their nationality 3,020 were French (2,896 males and 124 females); of the 736 students of other nationalities, 434 were males and 302 females.

Electric Power-station at Antivari.—A concession for establishing an electric power-station at the Adriatic port of Antivari has lately been granted by the Government of Montenegro. The dynamos to supply the electric energy to be used for industrial purposes will be driven by water-power.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

EXAMINATIONS.

The results of the Intermediate Examinations (Stage II.) will be published early next week. The results of the Elementary Examinations (Stage I.) will be published about the end of August. The results of the Advanced Examinations (Stage III.) were published on the 6th inst.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE APPLICATIONS OF ELECTRIC HEATING.

By Professor J. A. Fleming, M.A., D.Sc., F.R.S., M.Inst.E.E.,

Pender Professor of Electrical Engineering in the University of London.

Lecture IV.—Delivered March 27th, 1911.

The Domestic Applications of Electric Heating.

In this last lecture we shall consider some of the applications of electric heating in connection with every-day life. Great as may be the present consumption of electric energy for private electric lighting, many competent judges are of opinion that a very large additional field for its use exists in connection with the generation of heat for domestic purposes.

At the same time it is clear that this widely extended use of electric energy in home life has not yet arrived in any large degree, and it will be desirable therefore to examine the reasons for this and discuss the retarding causes now in operation. Apart from minor uses which are not at present important, and leaving out of account the use of electric energy for motive power, the demand for heat in our houses arises from the necessity for water heating, air heating, and food heating. We have to consider the nature of the appliances, their durability and prime cost, and the cost of working; also their economy and advantages as drawbacks relatively to other methods of heating.

It will be well to describe first those operations and appliances which can be easily and accurately brought into comparison when using different methods of heating. Whilst leaving certain general questions for discussion later, we may say at the present moment that one cause retarding the domestic use of electric energy for heating purposes is ignorance of the methods of usage and of the cost, and hence any information which tends to dissipate this ignorance will unquestionably assist the experimental or tentative adoption of these newer methods of heating. Another and most influential cause is that houses are not yet wired properly for the supply of electric-heating current in our rooms.

Let us consider, first, some of the facts in connection with water heating, because the supply of hot water, in small or large quantities, is a prime necessity in modern domestic life.

Consider the energy required to raise any mass of water from the ordinary air temperature, say, 60° F., just up to the boiling point, or 212° F. This involves raising it through 152° F., and since one pint of water weighs 1·25 lbs. and one gallon 10 lbs., it is clear that to raise one pint of water just up to the boiling point requires 190 B.Th.U., and one gallon requires 1,520 B.Th.U. to be imparted to the water. Since 1 B.Th.U. is equal to 0·294 watt-hours, it is seen at once that the energy required to raise one pint of water from 60° F. to 212° F. is 55 watt-hours, and to raise one gallon through the same temperature requires 440 watt-hours.

As all heat can be reckoned in energy units, and since electric energy is supplied to our houses at so much per kelvin, or Board of Trade unit, and since one kelvin equals 1,000 watt-hours, it is obviously an advantage to measure each operation of heating, whether of air, water,

or food, by the energy in kelvins required to produce the desired effect. Hence to heat the gallon of water from 60° F. to 212° F. requires 0·44 kelvin. Otherwise, 2·27 gallons of water could be raised from 50° F. to 212° F. by imparting to it energy equal to one kelvin.

Electric energy is supplied in our houses by the corporations or electric supply companies at so much per kelvin, generally 4*d.* to 6*d.* for lighting and 1*d.* to 1½*d.*, or, in some cases, less, for heating. Hence, if we reckon our energy consumption in kelvins, it gives us at once the cost in pence, assuming it sold at one penny per unit. The heating of the gallon of water up to boiling point requires 0·44 kelvin, as far as the heating of the water itself is concerned. Again, to provide ten gallons of hot water at 110° F., raised from 60° F., for a bath requires 5,000 B.Th.U. to be given to the water, equivalent to an expenditure of 1,470 watt-hours, or 1·47 kelvin.

The above figures for the energy absorption do not, however, give us the cost of the operation because, owing to thermal losses, more energy has to be employed than that represented by the temperature rise of the known weight of water. The user has to pay for these losses Hence we cannot give an answer to the question as to the cost of the electric heating, even when the price at which electric energy is supplied is known, until we have ascertained the efficiency of the various types of electric kettles, boilers and water-heaters employed. By their efficiency, we mean the ratio between the energy actually employed in heating the water to the total amount given to the heater, this ratio being expressed as a percentage. The simplest method of heating water electrically, and one which requires least alteration in ordinary water-supply arrangements is to use an *immersion heater.* This consists of some kind of high-resistance substance, often a wire coiled compactly and enclosed in a water-tight tube, the ends being brought out above the water surface. When a current is sent through the wire it is heated and imparts its heat to the water. As regards the durability of the resistance wire, there is some difficulty in getting any metal other than pure platinum, which is out of the question, to stand heating continually if air has access to it without oxidation and consequent deterioration. Even if heated in air free access of air should be prevented. We must have a wire of high specific resistance, high melting-point, and as non-oxidisable as possible. Nickel or certain alloys of nickel, such as the alloy called Nichrome, appear to answer these conditions best. A durable heater can, however, be made with silundum or with kryptol enclosed in water-tight cases. The heating resistance should be as far under the water as possible, in order to accelerate the heating by convection. The three sources of loss are—(1) radiation, air convection, or conduction from the cistern or vessel containing the water; and (2) loss of heat by conduction out of the electrodes; (3) heat carried away as latent heat of evaporation by escaping water, vapour or steam. The water vessel must, therefore, be closed, and either well lagged with non-conducting composition or else highly polished on the outside to reduce these losses. A difference of opinion exists as to which procedure is the best. If the polished exterior is to be kept effective as a non-radiator it must be kept bright, and this involves periodic labour. It would be impossible in the case of a hot-water cistern of any large size, although feasible in the case of electric ovens and small water-heaters. An experiment showing the value of external polish in preventing loss of heat in electrical heaters was mentioned in the *Electrical Times* of October 31st, 1910, which we take the liberty of quoting verbatim:—

Two water-heaters, each containing two gallons, were placed side by side and connected to an electric supply. One was of cylindrical shape, and was of highly polished tin plate, *i.e.*, tinned iron. The other was of sheet copper of triangular form, painted a dark glossy colour. Both had loose fitting lids, both took 800 watts, and both were switched on at once, the polished vessel boiling in about 80 minutes, the other heater taking somewhat longer. When both were boiling vigorously, the current was switched off, and the vessels were left all night without being touched. The time of switching off was exactly 12.0 midnight. At 8.15 next morning the temperature of the water in both was taken carefully, with the result that that in the cylindrical and polished vessel was 112° F., and that in the triangular copper heater was 80° F., a loss respectively of 100 and 132 degrees in 8¼ hours. If the triangular vessel had been painted dead black, instead of having a glossy surface, the loss would, no doubt, have been more marked, but the difference in the two figures is sufficient to show that a very high degree of efficiency can be secured with vessels costing but a few shillings, provided they are constructed on the right lines, and are carefully polished in the first instance, and kept bright afterwards. In the above experiment, the conditions were in reality more favourable to the triangular vessel than to the cylinder, for the former was hung on a brick wall, and had its heating elements self-contained, while the cylinder was placed on a hot plate and left

there all night. A substantial loss by conduction must have resulted through the large metal surface of the hot plate, with which the water urn was in close contact.

Now this may be all very good from a purely scientific point of view, but in domestic use the maintenance of high polish means labour, and in the present state of the domestic servant question it is, to say the least, highly improbable that this labour can be secured. Hence, since ordinary cisterns cannot be polished on the outside, they must be well lagged with non-conducting substances. The best way is to enclose the metal water-cistern in a larger wooden box, and pack the interspace, which should be 4 to 6 inches thick, with magnesia, asbestos, cork powder, or slag-wool, or any good thermal insulator. The cistern should, of course, be covered and lagged on the top, and the wires connected with the immersion heater brought out through the lid. As an instance of the great importance of lagging, an immersion heater of this kind is now exhibited to you in operation taking 800 watts or 8 amperes at 100 volts. Two galvanised iron cisterns, holding about 3 or 3½ gallons, were obtained. One of these was left bare, and the other fitted into a larger wooden box, the interspace being filled in with wood shavings ; 2·5 gallons, or 20 pints, of water were then placed in each cistern, and the 800-watt immersion heater used to heat the water from 60° F. to 212° F. Theoretically this requires 1·1 kelvin (= 2·5 × 0·44), but actually in the lagged cistern it did require 1·32 kelvin, or 8 amperes, at 100 volts for 1·65 hours. Hence, the efficiency in this case is 83 per cent.

In the unlagged cistern the water could not be heated to boiling by 800 watts in any time. The thermal losses were so large that this rate of supply of energy was not sufficient to balance them. Hence, lagging is of importance in reducing the rate of supply of energy as well as increasing the efficiency. If the energy is supplied for 1*d.* per unit the above water-heating in the lagged cistern would have given us 2½ gallons of boiling water for 1·3*d.* This, however, is by no means the best that can be done. A large part of this loss is due to the heat carried away as latent heat of vaporisation by the escaping water vapour, and if this is to be prevented the cistern must be provided with a close-fitting lid and a condensing tube, so that the vapour shall be condensed and the warm water returned to the cistern.

With proper arrangements of this kind it is possible to raise the efficiency nearly to 100 per cent., but never quite, because some energy is carried off by heat conduction in the leads. Nevertheless, it is a fair statement to make that by an expenditure of 0·5 kelvin one gallon of water can be raised from 60° F. to 212° F., or with energy at 1*d.* per unit the gallon of water can be raised from 60° F. to 212° F. by an expenditure of ½*d.* A similar immersion heater on a small scale can be employed to heat a glass of milk or water by immersing the heater in the liquid and connecting it to any electric lamp socket. Thus, the small heater shown, made by Messrs. Isenthal, takes 200 watts or 1 amp. at 200 volts, and will raise one pint of water from 60° F. to boiling with an expenditure of 90 watt-hours, or 200 watts for 0·45 hour. This gives an efficiency of only 61 per cent., but the heating was conducted in a bare glass jar. Using a glass vacuum vessel or thermos bottle, the energy taken fell to 78 watt-hours

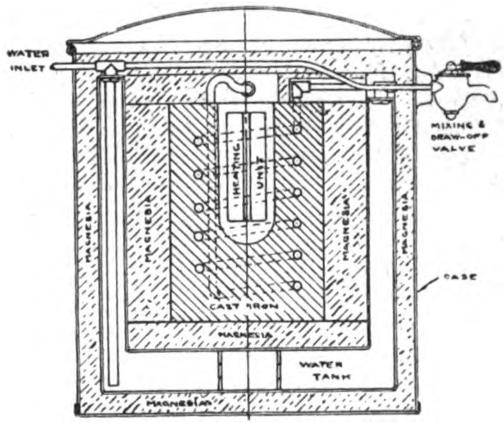

Fig. 34.—Section of Therol Electric Water-Heater (Spagnoletti).

and the efficiency rose to 71 per cent. Hence, at 1*d.* per kelvin, the cost is 0·078*d.*, or about $\frac{1}{12}$*d.* A very convenient way of warming milk, soup, or water at the bedside is to use a thermos bottle, and an immersion heater of the kind, and plug into a wall socket or lamp socket in the bedroom. On a much larger scale hot water is conveniently obtained electrically by an arrangement called a therol, brought out by Messrs. Spagnoletti, Ltd. It consists of a block of iron enclosing a coil of steel pipe (see Fig. 34). In the top of the block is a recess or cavity to contain the heating resistance, which is a Nichrome wire. These elements can easily be renewed, but are said to last two years or more. The block of iron is insulated by thick magnesia lagging. Outside this is a water-jacket, from

which the supply of water is drawn through the steel coil. This, again, is contained in a well-lagged vessel. The standard size of heater takes 200 watts—that is, 1 ampere at 200 volts, and is said to give 9 gallons of boiling water or 25 gallons of water at 110° F. per day.

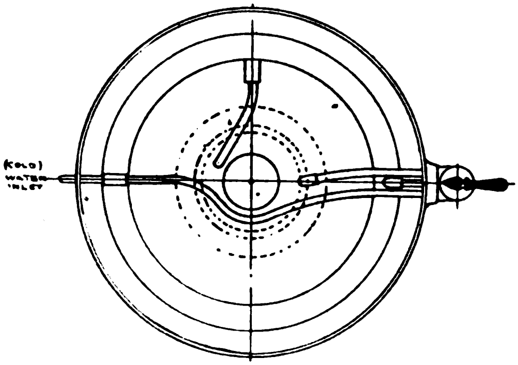

FIG. 35.—PLAN OF THEROL ELECTRIC WATER-HEATER.

In a factory experiment made with a therol having a 300-watt heater, taking 3·3 amps. at 95 volts run for 24 hours, and taking up therefore 7·5 kelvins, 38·4 gallons of water were drawn off at one run at 110° F. This implies that 384 lbs. of water had been raised 60° F. or 23,040 B.Th.U. imparted. The energy put in electrically was 7·5 × 3,400 B.Th.U. = 25,500. Accordingly, the efficiency of the heater in this experiment was 92 per cent. nearly. Now many corporations will supply electric energy at ½*d.* per unit for uninterrupted supply, and at this rate the cost of heating the 38·4 gallons of water to 110° F. would be 3¾*d.*, or about 1*d.* per 10 gallons.

The one defect of such an apparatus is the slow rate of heating, but Messrs. Spagnoletti have recently introduced an improvement called an accelerator in which a thermostat closes a circuit when the temperature of the water falls below a certain limit, and causes a relay to cut into circuit an additional 1,000-watt heater contained in the pocket of the therol, and so raises the temperature of the water in the reservoir more quickly again to the high temperature (see Fig. 36). A 200-watt therol fitted with 1,000-watt accelerator can give 130 gallons of water at 110° F. per day if required.

The importance of the use of the therol, from the supply station point of view, is that it provides a steady load, and hence enables a lower charge for the electric energy to be made, not only for the therol itself, but for other heating and cooking purposes. In poor neighbourhoods the supply of hot water publicly by charge at so much per gallon by some form of penny-in-the-slot system might be made a means of raising the load factor of public supply stations, and so reducing the cost of generation. Another similar water-heating arrangement has been brought out by the Armourduct Manufacturing Company under the name of a therma. In this appliance water is stored in a well-lagged cylindrical tank, and is heated by a wire-resistance made of a narrow ribbon of nickel alloy, wound specially on flat sheets of mica. There are two resistances—one low and one high—to effect the first heating, and afterwards by an automatic switch to maintain the water at 160° F. For the 15-gallon size the heating units take 2,000 and 150 watts respectively, the entire contents of the tank being raised from 60° F. to 160° F. in 2½ hours. According to these figures the efficiency should be 90 per cent., and the cost at 1*d.* per kelvin would be ⅓*d.* per gallon of water delivered at 160° F.

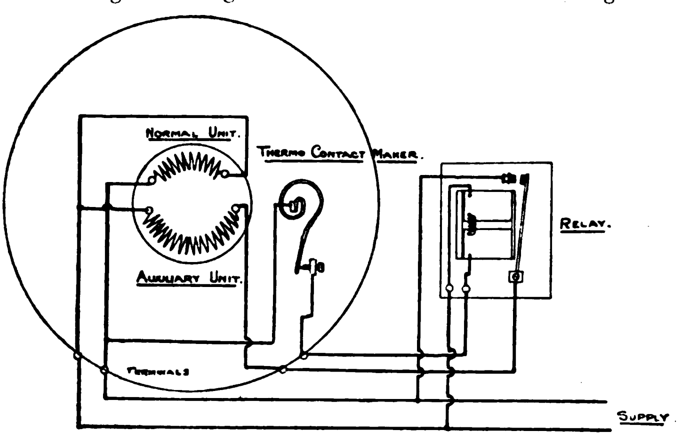

FIG. 36.—ARRANGEMENT OF CIRCUITS IN SPAGNOLETTI ACCELERATOR.

There is another water-heater called a Fuller geyser, in which the heating resistance is the water itself. The water passes through a chamber containing a porcelain cylinder with porcelain caps on each end. Inside this cylinder are a number of sheet platinum diaphragms separated by porcelain rings. Alternate diaphragms are connected together and to the electric supply mains. The cold water flows between the diaphragms and through circular apertures cut in them and is traversed by a current. The water is partly electrolysed and the gases escape with the steam. There is, therefore, no resistance to burn out. A geyser to deliver one pint of hot water per minute is said to take 1,000 watts. Hence sixty pints could be heated in one hour by an expenditure of one kelvin. This type of heater is apparently best adapted to deliver a small quantity of water rapidly, as for a wash-hand basin.

This leads us, then, to notice the various types of electric kettle and water-boiler for cooking and other small purposes. We may divide existing types of apparatus into two classes. There is first the type of kettle or boiler which contains in itself a heating resistance of some kind, and therefore is a special article. Thus, for instance, a Prometheus kettle has a double bottom, and in the cavity embracing the inner vessel is a band of high-resistance material between two strips of mica. Often two bands are used to give two rates of heating. The connection to the circuit is made by a flexible conductor and plug connection. In using such a kettle the current must not be switched on before the water is placed in it, and must be switched off before pouring the water out.

The efficiency of such a kettle can be measured by noting the power in watts and time required to bring a pint or quart of water from 60° F. just up to the boil. Thus with a Prometheus kettle of quart size, having two pints of water in it, it was found that 130 watt-hours were required to bring the quart just to the boil. It required 4 amperes at 100 volts for twenty minutes. The theoretical amount of energy required is 110 watt-hours. Hence the efficiency is 84 per cent.

A Prometheus saucepan taking 600 watts required 105 watt-hours to raise 1¾ pints to the boil, which is at the rate of 60 watt-hours per pint, or an efficiency of 91 per cent. Hence it is clear that water-heaters constructed on this plan can have an efficiency as high as that of a good dynamo or motor.

Another mode of electric heating for water-boiling or cookery is to employ an ordinary kettle or saucepan over an electric hot plate or incandescent radiator. Thus we may heat a silundum grid red-hot by a current and then put an ordinary kettle full of water over it as if it were a fire. In this case, however, the radiation losses from the heater are considerable, and the efficiency of heating becomes much less. An experiment made with a silundum heater and various kettles gave results as follows:—Using a bright tin kettle and one silundum heater taking 500 watts, it was found that one pint of water was raised from 60° F. to 212° F., with an expenditure of 117 watt-hours. This gives an efficiency of only 47 per cent. Using two silundum heaters in series taking 1,000 watts, the pint was boiled with 120 watt-hours and an efficiency of 46 per cent.

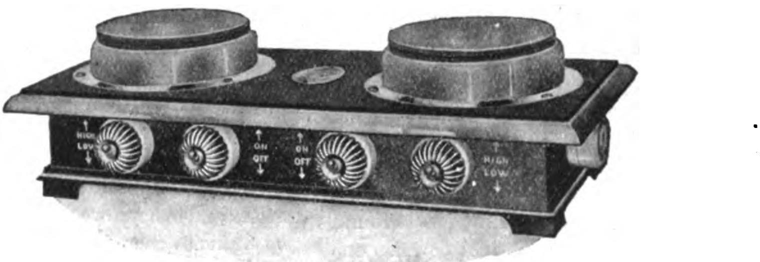

Fig. 37.—"Tricity" Hot Plate for Electric Cooking and Heating.

If a hot-plate heater is used, such as a Berry "Tricity" cooker (see Fig. 37), it is important that the kettle should have a perfectly flat bottom and make good contact with the heater; otherwise there is a loss in efficiency. Hence the class of kettles which are most efficient with gas-rings are not most efficient with electric hot plates.

In the case of ordinary coal-gas employed as a heating agent with the usual gas-rings we may reckon that each cubic foot of London gas at 60° F. and 30 in. barometer, has in it potential

energy available for heating equal to about 550 B.Th.U. This calorific capacity varies somewhat from day to day according to the chemical constituents of the gas. Since 1 B.Th.U. = 0·294 watt-hour, we may say that the intrinsic or gross calorific capacity of London gas is about 162 watt-hours per cubic foot, or 162 kelvins per 1,000 cubic feet. The question then arises: How much of this 162 kelvins can we utilise in water-heating?

I find much depends on the kettle and the gas-ring. For each kettle there is an appropriate size of gas-ring and certain rate of supply of gas, which gives the best efficiency (see Fig. 38).

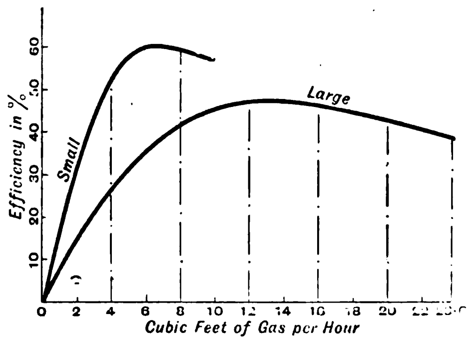

FIG. 38.—EFFICIENCY CURVES FOR LARGE AND SMALL RING BURNERS AT DIFFERENT GAS FLOWS.

Taking an enamel iron kettle holding one quart and putting it over a large gas-ring, it was found that it required 0·9 of a cubic foot to raise one pint of water to the boil. This means that energy equal to 146 watt-hours was supplied as gas burnt to impart 55 watt-hours to the water. The efficiency, therefore, is only 34 per cent. Using a smaller gas-ring, the gas burnt was only 0·67 cubic foot for the same duty, equivalent to an efficiency of 53 per cent. If a bright tin kettle was employed, the consumption was 0·61 cubic foot, an efficiency of 58 per cent., and if a "kwik" kettle, or one having water tubes in the base was used, the gas consumption fell to 0·55 cubic foot and the efficiency rose to 61 per cent.

Using three pints of water in a bright tin saucepan over a small gas-ring gave a consumption of 0·62 cubic foot per pint and an efficiency of 58 per cent.

It is clear, therefore, that using an ordinary tin or iron kettle over a suitable gas-ring we cannot obtain a much higher efficiency than 60 per cent. On the other hand, with the electric kettles we can obtain an efficiency of 80 per cent. or more. The ultimate question, however, is one of cost. If electric energy is supplied at 1*d.* per unit, then the best electric kettle will take 60 watt-hours to boil the pint of water, costing ·06*d.* The best ordinary kettle and gas-ring will take 0·55 cubic foot of gas, which, at 2*s.* 9*d.* per 1,000, will cost ·018*d.* Accordingly, for the small operation of boiling a pint of water, the gas has the advantage in mere cost, but many disadvantages from other points of view. If, however, we take into account the fact that gas burners in the hands of domestics are nearly always lit before they are wanted, and left burning after they have been used, the practical ratio between the cost of small water boiling by gas at 2*s.* 9*d.* per 1,000 and electric energy at 1*d.* per unit is not nearly so large as 1 to 3. It is more like 1 to 2, or even 1 to 1. As regards larger quantities it is easy to show that to provide ten gallons of hot water at 110° F. for a bath, raising it from 60° F., requires the expenditure of 2 kelvins. This at 1*d.* per electrical unit costs 2*d.* My experience is that to do it by gas requires 30 to 40 cubic feet of London gas, costing 1*d.* to 1⅓*d.* It must be remembered, however, that each cubic foot of gas requires, roughly speaking, two cubic feet of air to burn it, and that the products of combustion and imperfectly burnt gas have to be got rid of. This renders the use of gas geysers, gas kitcheners and gas heaters generally, except on a very small scale, impossible without adequate ventilation, and therefore the comparison of the two agencies merely on the basis of cost of gas and cost of electric energy is unfair.

As a final result we may say that water heating by electric current is not only practical on a large or small scale, but that even at the present cost of electric energy it is not at much disadvantage compared with gas at 2*s.* 6*d.* per 1,000, whilst if electric energy can be generally supplied at a cost of ½*d.* per unit for domestic heating, as it is in some places, the advantages will be all on the side of the electric heating. Furthermore, we may say that in the public supply of hot water for domestic purposes there is a source of revenue for electric supply stations which has hardly yet been touched.

We have in the next place to consider electric heating for other culinary purposes. A large part of the operation of cooking consists in exposing the edible material to such a temperature that if of animal nature the albumen in the flesh is coagulated, but not at such a temperature as to render it insoluble in the gastric juices. Also other operations involve the partial conversion of starches into dextrine, as well as the softening of animal or vegetable tissues by heat.

The heat for the purpose must be capable of ready variation over a range of temperature from 100° F. to 500° F.

The following are the temperatures required for various operations, on the authority of Senn, and are quoted from an excellent handbook called "Electricity for Everybody," by Mr. R. Borlase Matthews (published by the Electrical Press, Ltd., 37–38, Strand, London).

SAUCEPAN.

Fast boiling	212° F.
Simmering	180°–190° F.

OVEN.

Roast Beef	300° F.
Roast Mutton	310° F.
Game and Poultry	310° F.
Meat Pies	290° F.
Pastry and Cakes	320° F.
Bread and Puff Pastry	340° F.

FRYING.

Fish	360°–375° F.
Meat	370°–380° F.
Fritters	340°–375° F.
Whitebait	400° F.

In many operations, however, such as baking meat, the temperature has to be high at first and somewhat reduced later, but every oven should be capable of attaining and keeping a temperature of 400° F. The ordinary family cook is in the habit of using her hand as a thermometer, but a thermo-electric junction can be fixed in an oven and connected to a direct-reading voltmeter outside, and will give at once, without opening the oven door, the right temperature.

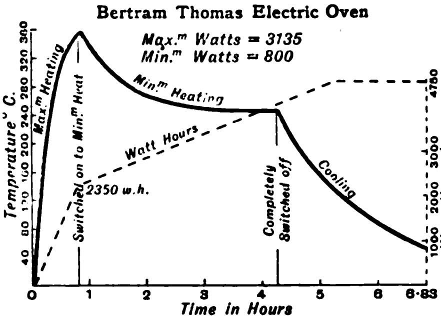

FIG. 40.—HEATING AND COOLING CURVES OF BERTRAM THOMAS ELECTRIC OVEN.

The electric ovens in use may be of two types: One which consists of an iron chamber heavily insulated with non-conducting material, in the walls of which coils of wire are embedded, which are heated by the current sent through them. As an excellent example of this type, we may mention the Bertram Thomas electric oven here exhibited (see Fig. 39), of which the heating and cooling curves are shown in Fig. 40. Two or three switches are generally provided, by means of which the heat is regulated. Such an electric oven has to be substantially built and well insulated to achieve its purpose. The second class of oven is nothing more than a light sheet metal box, highly

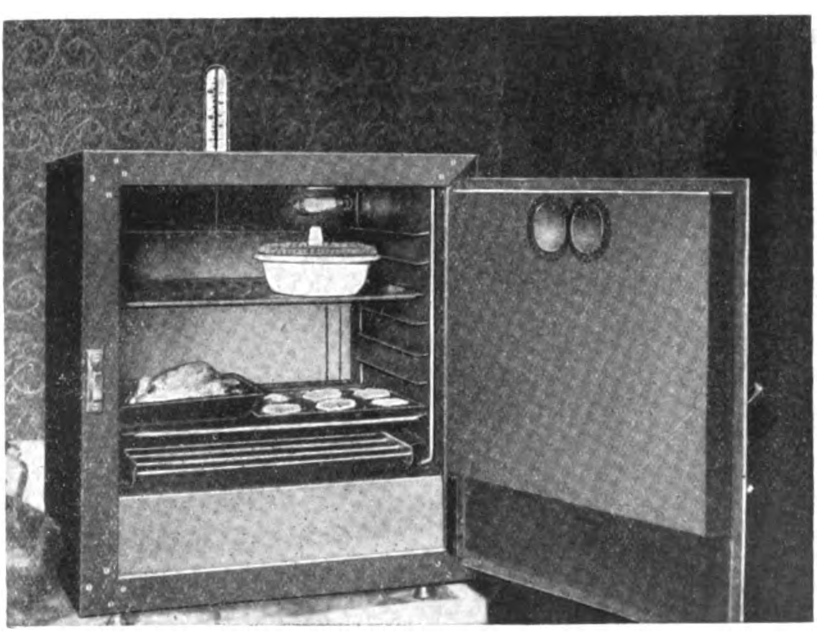

FIG. 39.—BERTRAM THOMAS ELECTRIC OVEN.

polished on the outside to prevent loss by radiation, placed over a hot plate in which heat is generated by passing a current through resistances. In the Berry "Tricity" system the heater

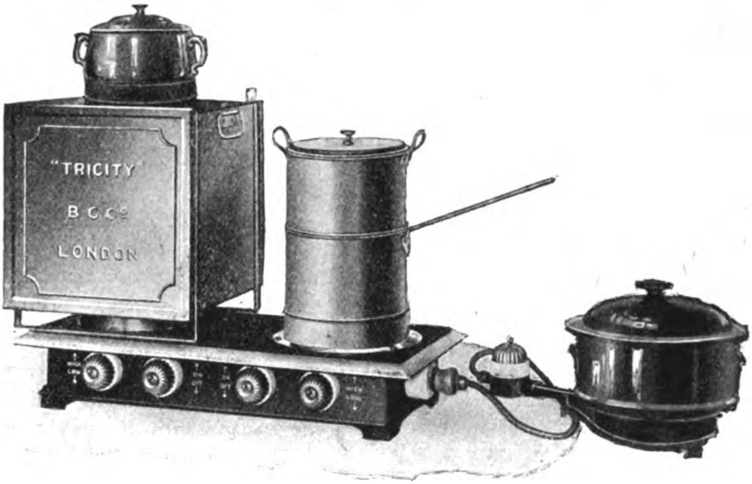

FIG. 41.—"TRICITY" COOKER. HOT-PLATES, OVEN AND STEW-PANS.

is a round iron plate containing the heating coil, which takes 800 watts, and is raised very quickly to 500° or 600° F., or something short of a visible heat. Over this plate can be placed a polished sheet-iron oven, and in the interior of this the culinary operations are conducted (see Fig. 41). In this case the radiation losses are kept small by the polish of the oven. In the Bastian system the heaters are Nichrome wires run at a low, red heat, and enclosed in quartz tubes (see Fig. 42). The oven is air-lagged and polished on the outside.

For frying or grilling we have the option of using the type of electric saucepans or grillers in which heating wires of a special alloy are embedded in enamel, the enamel being so composed that it has the same co-efficient of expansion as the wire, and does not, therefore, tend to break away from the wire when hot.

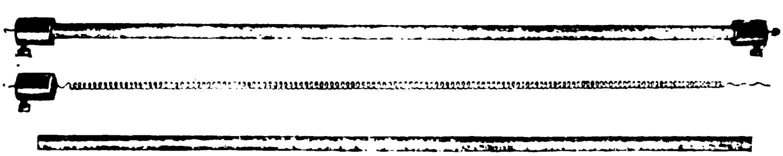

FIG. 42.—QUARTZ TUBES, WITH NICHROME SPIRAL WIRES, USED IN THE BASTIAN SYSTEM OF ELECTRIC HEATING.

Or we may use ordinary saucepans or grillers on an electric radiator in which some resistance material is heated to incandescence, this radiator taking the place of the coal-fire. Broadly speaking, we may say that when we use the special electrical vessel with embedded resistances we can obtain the highest energy efficiency, because we can most perfectly insulate it, and prevent the heat from escaping in directions where it does no work. On the other hand, such vessels are bound to be more expensive, heavier, and more fragile, or easily injured, than the ordinary culinary vessels. Hence they have less durability in ordinary domestic use.

On the other hand, those systems in which an electric heater or radiator is employed to take the place of the ordinary fire or gas-ring, and on which ordinary saucepans, kettles, or a similar class of vessel are used, may give less efficiency, in an energy sense, because there may be a greater wasteful loss of heat.

Now, the cost of cooking, apart from the cost of materials and wages, is made up of the cost of energy or fuel and the cost of the apparatus distributed over its useful life. Thus, if an electric kettle costs 15*s.* to begin with, and has to be repaired even only once a year at a cost of 5*s.* each time, and lasts, say, three years, we should have to consider the cost of the appliance as 10*s.* per annum. On the other hand, if an ordinary gas-ring and enamel iron kettle cost 6*s.* to begin with, and needs no repairs, but lasts six year, the cost of apparatus is 1*s.* per annum.

Hence the initial outlay and the cost of repairs and life of the appliance are a very important element, and have to be taken into consideration as well as the cost of electric energy as compared with gas or coal. Whatever type of oven may be employed, it is necessary to be able to regulate the temperature easily and quickly. Everyone knows that in cooking a joint of meat the temperature has to be high at first to coagulate the albumen on the outside and seal in the meat juices. Then the temperature has to be lowered to continue the process of cooking so as not to coagulate the albumen in the interior beyond a certain point. Hence switches have to be provided, giving at least three stages of temperature. Also a thermometer or pyrometer indicating the temperature in the interior, and it is a convenience to have a mica window and electric lamp—as in the Bertram Thomas oven shown in Fig. 39—so as to watch the process without opening the door. In using an electric oven, it is generally necessary to get up the temperature first before inserting the food, and this is most conveniently done when a thermometer is provided. The electric oven has, of course, the great advantage over the gas oven that the interior is free from the products of combustion.

There is, however, a large field for improvement still open in those appliances. As regards electric cooking apparatus generally the following qualities are essential. Anything required in ordinary domestic use has to be strong and simple and easily managed, and in the present state of the domestic labour market the less cleaning required the better. Hence such modes of connection to the circuit as porcelain two-pin wall-plugs and flexible cords are out of place. Highly-polished copper kettles and nickel-plated vessels look very pretty when new, but involve a great labour to keep bright, and lose much of their advantages as non-radiators if not kept bright. Most people cannot afford to keep a large number of spare duplicates. Hence expensive vessels must be so made that they cannot get out of order, which is very far from being the case with many of the present types of electric cooking apparatus. Some automatic arrangement must be provided which ensures that the resistance wire shall not be burnt out if the vessel is left empty. Such arrangement is provided in the case of electric cooking vessels and water-heaters provided by Messrs. Isenthal. Again, the advantages of low voltage are supreme in the case of electric cooking. It is nothing short of a crime to place in the hands of ordinary domestic servants electric cooking apparatus worked at 220 volts off one side of a 440 volt service. In the case of cooking by electricity, just as in the case of lighting by metallic filament lamps, the advantages are all on the side of alternating current supply, as then the voltage can be reduced to 50 or 25 volts, and be made safe in the hands of a child.

The chief fault of much of the present electric cooking apparatus is that it does not supply a sufficiently high temperature or supply heat quickly enough. In cooking it is necessary to be able to command high temperatures quickly for a short time. This is why such a simple operation as making a piece of toast is better carried out by the ordinary coal fire than by most of the electric toasters.

It is necessary to be able to force or delay the process of heating at pleasure, and the present electric cooking apparatus is deficient in this respect. Furthermore, many of the appliances in the market for electric cooking are either too costly or too flimsy. Cost, however, is a matter of production.

We are at present in the condition as regards electric heating in which we were in 1883 or 1884 with regard to electric lighting. The price of the electric energy cannot be reduced until the demand is greater and the cost factor improved. The demand cannot arrive until the facilities for using the current are given, and it will, therefore, only at first appeal to those who can make the necessary expenditure in wiring. What is now chiefly required as a preliminary condition is that the ordinary speculative builder, when erecting houses, shall provide separate and proper electric wires for heating circuits. Experience, however, shows that electric cooking is on a different basis as regards cost to electric water heating. When once an oven has been brought up to the cooking temperature the only reason for supplying more energy is to make up the losses by radiation and convection. It is possible to reduce these losses to a very small amount, and yet to maintain the required cooking temperature. In electric cooking the food is not contaminated with the products of combustion. Ovens can have a more uniform temperature in them than when heated by gas or coal, and also food, such as meat, wastes less or loses less in cooking by electricity than by gas, and has also a better flavour. As regards the costs of it, a rough-and-ready rule appears to be that when the cooking of a household is conducted entirely by electricity, it requires one unit (one kelvin) per day per person plus one

or two units for the energy losses. Thus six kelvins per day should do the cooking for four persons taking the usual three meals per diem, provided they are not elaborate.

We have, then, in the third place to consider the question of air-heating or house-warming by electric heating. In addition to food required for the sake of maintaining animal heat we find ourselves under the necessity of maintaining a certain internal air temperature if we are to be thoroughly comfortable, and the limits of this are rather narrow. We may say that 60° F. to 65° F. is the normal healthy room air temperature. If it falls below 45° F. or 50° F. we feel it cold, and if it rises to 70° F. or 75° F. we feel it to be warm.

Hence for comfort and health the air in which we live should be maintained as far as possible

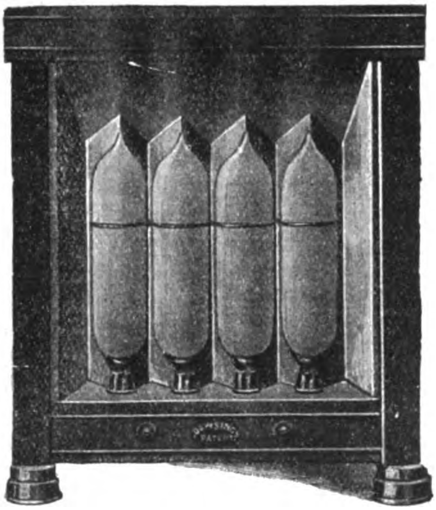

FIG. 43.—COMBINED LUMINOUS RADIATOR AND CONVECTOR, BY THE DOWSING RADIANT HEAT COMPANY.

at 60° F. But more: we are acutely sensitive to the hygrometric condition of the air, or to the percentage of water vapour in it. If it is very dry we experience sensations of enervation, and also if very moist. About ten litres of water vapour per cubic metre of air, or about 1 per cent. of water vapour by volume in the air, appears to be a comfortable amount. Also health and comfort are greatly determined by the organic matter in the air. Now the ordinary methods of house heating are acknowledged to be extremely unscientific and wasteful, yet nevertheless there is something to be said in favour of them, as they at least produce some degree of ventilation necessary to renew the air in our rooms and carry away the products of organic contamination. And it is not only necessary that the temperature and moisture should be kept within limits, but equally so that the organic contents of the air and its carbonic acid contamination should be kept below a certain amount. We all know that a room without a fireplace and chimney is never so healthy as one in which there is a fire. We shall not be able to afford time to discuss the advantages or disadvantages of heating by coal fires, anthracite stoves, gas fires, or hot air heating, but must confine ourselves to the problem of electric room heating. There are two systems of doing this, one by luminous radiators, first introduced by Mr. H. J. Dowsing, and the other by non-luminous heaters or convectors. Lately, however, the two systems have been combined by inventions due to Messrs. Dowsing and Huntley (see Fig. 43). Air, being very diathermous, can only be heated by being brought in contact with a hot body. If the radiating body is luminous, that radiant heat can only heat the air by falling on surrounding bodies such as the furniture and walls of the room, which absorb this heat, become hot, and in turn heat the air by contact. On the other hand, that radiant heat may heat our persons by falling on our clothes or flesh and heating them. What is really required, however, is the heating of the air generally. Nevertheless, most persons would agree that a source of luminous heat in a room gives it a cheerful appearance, and that a room heated by a hot-water or steam-pipe radiator is never so attractive as a room which has in it a gas or coal fire or luminous radiator of some kind.

It is important, as a preliminary to further discussion, to consider the amount of heat required to raise a given volume of air to a given temperature. At ordinary temperature and pressure 12·35 cubic feet of air weigh 1 lb. Hence 1,000 cubic feet of air weigh very nearly 80 lbs. The specific heat of air is 0·2375. Hence to raise the temperature of 1,000 cubic feet of air 1° F. requires 80 × ·2375 B.Thu.U., or 19·24 B.Th.U. = 5·65 watt-hours. Suppose the air is raised from 32° F. to 65° F. or through 33° F., then to raise 1,000 cubic feet of air from 32° F. to 65° F. requires 186·45 watt-hours, or 0·186 kelvin, or roughly one-fifth of a Board of Trade unit of electric energy. Suppose the room to be heated to be a room of about 2,500 cubic feet. Then to heat the air in this room from the freezing-point to a comfortable temperature of 65° F. would theoretically require only 0·5 kelvin. The air has, however,

to be renewed at least twice an hour for the removal of carbonic acid and organic products, and hence it would require at least 1 kelvin even for the mere air heating. Practically it would require far more than this, and a good deal more even, if the doors and windows are closed and there is no renewal of the air. The reason for this is that the walls and window, floor and ceiling absorb heat at a very considerable rate, and as it is not possible to raise their temperature sensibly, we may say that heating the air of a room is an operation like pouring water into a leaky vessel or trying to fill a bath when the waste plug is open. In this last case, in order to raise the level of the water at all, we must let in the water faster than it runs out, and the depth to which we can fill it depends on the ratio of the rates of inflow and outflow. So in the case of room heating, the demand for heat does not arise nearly so much from the heat capacity of the air itself as from the heat escape through the walls and windows.

Some curves, taken by Mr. A. R. Wolff, and kindly supplied to me by Mr. Huntley, the engineer of the Dowsing Radiant Heat Company, show in a remarkable manner the great loss of heat in ordinary houses through windows, thin walls, and skylights, and the immense advantages of double windows and walls (see Fig. 44). If our houses were only constructed on scientific principles so as to be heat tight, or at least less diathermous than they are at present, we should be astonished to find how little energy expenditure would keep us warm. The house of the future will have double walls, double windows, no chimneys, ventilation by electric fans, the incoming air heated electrically, and all the cooking and warming provided without any form of combustion or necessity for chimneys requiring constant sweeping. As constructed at present, however, experience shows that a rate of supply of electric energy equal to one watt for every cubic foot of air in a room will in general maintain it at a comfortable temperature in winter.

Hence, in the case of the room of 2,500 cubic feet capacity it would require at least 2·0 kelvins per hour or 2 kilowatts to be supplied to it to keep it warm in winter by electric heating. This is equivalent to a complete renewal of the air every 2½ hours. Since electric heating does not vitiate the air, and does not require any chimney, the ideal method of heating and ventilating a room would be to exhaust or draw out the vitiated air and heat the incoming air at the point where it is drawn in. It is clear, however, that nothing could be more unscientific than the ordinary system of room warming by gas or coal fires. The greater part of the heat goes up the chimney with the products of combustion. The incoming air is not warmed, but makes draughts along the floor, and the utmost that can be said is that the fire looks cheerful and ventilates the room.

Experience shows that a gas stove, as usually employed, suitable for warming a room of about 2,000–2,500 cubic feet, takes 50 cubic feet of gas per hour. Now, this amount of gas contains about 25,000 B.Th.U. total calorific energy, equivalent to about 8·0 kelvins. Hence, since about 2·0 kelvins per hour supplied to electric radiators will warm the room at the same rate, the average gas fire may be sending up the chimney energy equal to 6 kelvins per hour. Hence, 75 per cent. of the available heat may pass up the chimney with the products of combustion, and 100 cubic feet of fresh air

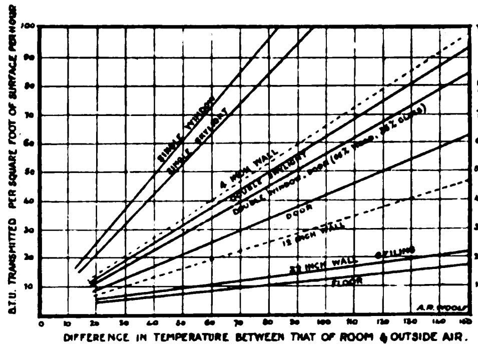

FIG. 44.—CURVES SHOWING THE LOSS OF HEAT IN B.TH.U. PER SQUARE FOOT THROUGH VARIOUS SURFACES. (A. R. WOLFF.)

has to be drawn in merely to burn the gas. As only 0·5 kelvin is required to heat the air itself from 32° F. to 65° F., the true efficiency of the gas fire can only be determined when we know how many hours' burning it would require to bring air in the room up to 65° F., and keep it at that temperature.

Electric room heating may be conducted by several kinds of heater—viz. (1) the luminous radiator; (2) the non-luminous radiator or convector; (3) the electroyl or hot-oil radiator; (4) the combined luminous and convector heater.

The luminous radiator consists in one form of two, three, or four cylindrical incandescent lamps, preferably carbon filament set in a reflecting hood with ornamental frame (see Fig. 43). The luminous radiation heats the bulbs and surrounding objects, and so warms

the air in contact with them. The second type of heater is the non-luminous convector,

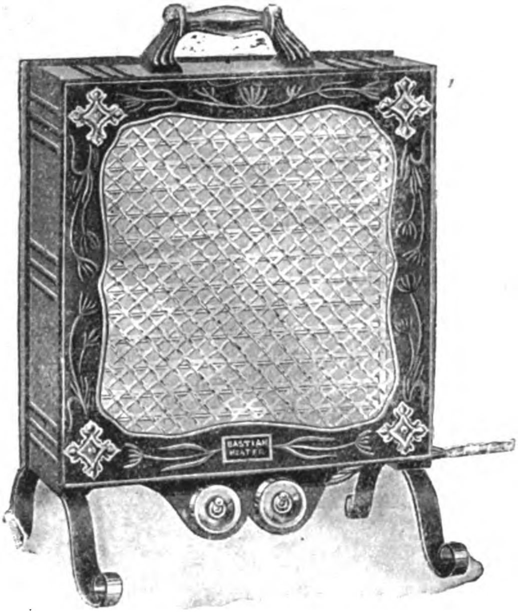

FIG. 45.—ELECTRIC CONVECTOR, OR NON-LUMINOUS ELECTRIC HEATER.

in which some kind of resistance wire is used to heat electrically a metal radiator with large surface (see Figs. 45 and 47).

The ordinary custom of placing a luminous radiator in the fire-grate to imitate a fire is entirely wrong. The air heated by contact with the radiator then mostly goes up the chimney instead of filling the room. The radiator or convector should be placed near the door so as to heat the incoming fresh air. Properly speaking, the fresh air should come in by special openings, over which the electric heater is placed, and the foul air should be removed by electric fans or Tobin's tubes (see Fig. 46, which shows such an electrical heater for heating incoming air, made by Messrs. Purcell and Nobbs). Moreover, the heaters should not be concentrated in one place. A room 16 ft. × 16 ft. × 10 ft. should have four radiators placed as far apart as possible, and not placed in the fireplace. In this manner distributed sources of heat tend to produce a uniform temperature of the air just as distributed lamps produce more uniform illumination. A system of luminous heating has been introduced by Mr. Bastian, in which spiral wires of a nickel alloy are enclosed in quartz tubes and heated to incandescence by the current. The quartz is quite transparent to non-luminous as well as luminous heat, and also serves as a mechanical support for the spiral.

In making a convector there should be two or three switches so introduced that the amount of heat generated can be varied. Thus, for instance, in heating a room (say) of 2,000 cubic feet the heater might be full on for one hour and then for eight hours at half-heat, using, say, 5 units in all.

The third type of heater is the low temperature electroyl radiator of Messrs. Purcell and Nobbs, in which the heat generated in a resistance wire is used to heat oil in which the wire is immersed, and the temperature maintained at 150° or 200° F. This type of electric heater is suitable for large rooms, and it is possible to have a luminous radiator, say, in one position so as to give a cheerful glow and non-luminous radiators in other parts of the room. The non-luminous radiators are made in various forms, suitable for heating ships' cabins, railway carriages, and offices. The relative advantages and disadvantages of these various kinds of electric heaters for room warming have been much discussed. The luminous radiators send out their

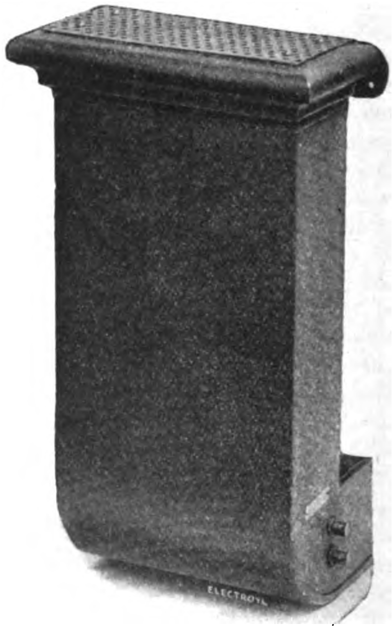

FIG. 46. ELECTROYL HEATER.
(Electric Tobin's Tube for heating the incoming air of a room.)

heat chiefly in a horizontal direction. The non-luminous, or convector heater is especially valuable in that it can be placed under windows

or skylights, and used to prevent down-draughts of cold air. Some results of experiments in room-heating by various electric methods are embodied in the curves shown in Fig. 48,

Fig. 47.—Electric Convector, or Non-Luminous Heater of Purcell and Nobbs.

supplied to me by the Dowsing Radiant Heat Company.

From a sanitary point of view electric heating is everything that can be desired. The glow-lamp heaters are suitable for occasional use, but require some outlay on lamp or spiral renewals. An excellent plan is to combine the luminous and non-luminous systems, ventilating the room by an electric fan, exhausting the air from the room at a point rather above the middle of the room, and then arranging three non-luminous heaters round the room, and a fourth luminous one for appearance.

As regards cost I have made some experiments in my own home on the relative cost of coal, gas, and electricity as heating agents.

Taking a room about 14 ft. × 20 ft. × 9 ft., having about 2,500 cubic feet capacity, I find that if a coal fire is kept running all day, say, for twelve or fourteen hours, it will use about 40 lbs. of coal per day, or $\frac{1}{8}$ ton per week. At 28*s.* this will cost 3*s.* 6*d.* per week, or $\frac{1}{2}$*d.* per hour for coal only, exclusive of wood or lighters, labour, and chimney sweeping.

I find that a gas fire of a good kind suitable for warming such a room takes 45 cubic feet per hour, and at 2*s.* 6*d.* per thousand the cost is $1\frac{1}{2}$*d.* per hour, or 7*s.* per week, running eight hours a day. As a matter of fact, such a gas fire will really cost somewhat less, because in the generality of cases it can be put out for some hours in the day without inconvenience and lit again at a moment's notice.

To do the same heating by an electric convector with electric energy supplied at 1*d.* per kelvin will cost about 2*d.* per hour, or about 9*s.* per week. Hence even at 1*d.* per unit it is not to be denied that electric room heating costs more than coal, but not much more than gas, whilst it has unquestionable advantages over either. When a sufficient demand springs up for electric energy for heating to enable the price to be lowered to $\frac{1}{2}$*d.* per kelvin, it will prove a most formidable competitor to both the older forms of heating, and in time will no doubt replace them both. Even now there is a large demand for electric radiators and convectors for heating ships' cabins and saloons, motor-houses, small offices, bedrooms, and any places where flame-heating cannot be used on account of danger of explosions. The present hindrances to its progress are, first, the want of proper electric heating wires in private houses. Electric heating circuits must be run to convenient points on the wainscot of kitchens, sitting-rooms, and bedrooms with appropriately placed fuses and switches. Then, in the next place, there must be a wider diffusion of the knowledge of how to use electric heating to the best advantages. Cheaper and more substantial appliances, both for cooking and room heating, must be placed on the market, and lastly the price per unit for electric energy for

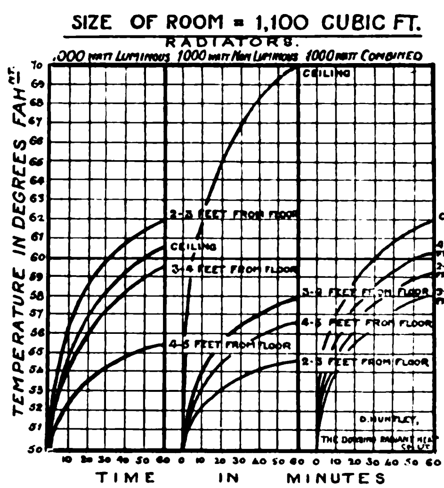

Fig. 48.

heating must come down to $\frac{1}{2}$d. Even at the present rates the advantages of electric cooking have only to be more widely known to be better appreciated, and it is not necessary to wait for

the perfection of electric room-heating before adopting it for cooking. The chief difficulty at present is the wiring problem and the absence of experience. But these obstacles can only be removed by degrees. The demand makes the supply, but the supply can only come from demand. Nevertheless, I have the firmest faith in the future of electric heating, not merely in the workshop and factory, in large metallurgical operations or mechanical arts, but in its home application in cooking, water heating, and room warming, giving us not only light and power, but the most perfect, cleanly, and convenient source of heat to meet all the demands of domestic life and serving to reduce the difficulties of monotonous but necessary domestic labours, which are not likely to be diminished in any other way.

TRAMWAYS AT MILAN.

The tramway system at Milan has developed of late years to an extent which no one could have believed thirty years ago. It was not until the year following the Exhibition held in that city in 1881, that the first lines worked by horses were opened. During that year (1882) the total number of passengers carried was 12½ millions, which was nearly doubled in the first five years, and trebled in the next ten, being:—

1886	24,012,817	passengers carried.
1896	35,548,801	" "

A further impulse was given in 1897 by the introduction of electric traction, when the network of tramlines was considerably extended, and the number of passengers carried, increased by 4,200,000, was:—

1897	39,748,801	passengers carried.
1898	44,548,801	" "
1899	57,740,801	" "

Since then a steady increase has been observed, partly due to the issue of workmen's tickets at a charge of only five cents in the early morning, and cheap fares generally. The opening of new lines, and the Exhibition of 1906, gave a further impetus to the popularity of the tramways. This was followed by a decrease in 1907; but since then the increase in the number of passengers has been steady:—

1904	86,634,059	passengers carried.
1905	94,384,365	" "
1906*	121,128,795	" "
1907	109,565,790	" "
1908	125,151,507	" "
1909	132,983,726	" "
1910	141,679,631	" "

In 1882 the average number of journeys made per head of population was only 32, as compared with 229 per head during 1910.

* Exhibition year.

The length of the lines of tramway on January 1st of each year was as follows:—

	Metres.	English Miles.	
1899	61,981	= 38·4	About one-sixth of total length of the streets of Milan, which was 336,610 metres (208 English miles).
1902	74,970	= 46·5	
1905	86,363	= 53·6	
1911	121,178	= 75·2	About one-quarter total length of streets, which are 509,282 metres (316·2 English miles).

THE MANUFACTURE OF JIPPI-JAPPA HATS IN JAMAICA.

What are generally known as "Panama" hats are not made in Panama at all, but chiefly in South America, especially in Colombia and Ecuador, and to some extent in several Central American States. The manufacture of these hats is an important industry in Ecuador, from which they were exported to the value of £250,000 in a recent year. In these countries the price of the hats usually ranges from two shillings to a guinea, but in Honduras some hats are made which sell for £5 each, and in Ecuador a kind called "Especiales" is made, requiring months of work to finish a single hat, which may sell there for £20 or even more. All grades of these hats are made from the leaves of a palm plant (*Carludovica palmata*), called locally in various countries Jippi-Jappa, from the canton of that name in the province of Manabi on the coast of Ecuador, where the finest of these hats are manufactured. The plant from which hats are made in Jamaica is said by some authorities to be exactly the same as that used in Colombia and Ecuador, but by others it is called Carludovica Jamaicensis, to indicate that there is a slight difference in the plants. The first hat of this kind manufactured in Jamaica was made in 1839 or 1840 by a Spaniard, who recognised the plant growing along the Cassava River as the same as that from which hats were manufactured in South America. In 1844, at a colonial exhibition at Spanish Town, the former capital of Jamaica, a prize of £20 was awarded for a hat of this sort made in the island. The making of these hats grew into so large an industry before the earthquake in 1907, owing somewhat to the purchases made by tourists, that a school was established in Kingston to instruct girls in the art. According to the United States Consul at Port Antonio, the plant which furnishes the material for the hats is a bushy palm growing in clusters along rivers and in damp places. Just before the long sheath or spathe which encloses the palm-leaf expands, it is cut off, the narrow outer blades on two sides are stripped off, the remaining portion is divided lengthwise into halves, and then, by sticking a pin or knife-blade through each half, the edge of the blades is split off on each

side, leaving a narrow strip of uniform width in the middle of the blades, the width being determined by the quality of the hat to be made, as the narrower the strips the finer the hat. These strips, still fastened to the stems, are boiled in water (salt and lime-juice being sometimes added) for half an hour and then dried in the sun. As they dry they shrivel up into a round, compact form, when the material, now ready for the hat-maker, is called "straw." It usually requires from twenty to thirty spathes or buds, which are twenty-five to thirty inches long, to furnish enough straw for an ordinary hat, the number varying with the size and quality of the hats. These hats are plaited or woven in one piece, the work being done chiefly by women and girls, although it provides occupation also for men in rainy weather, or whenever they have no outdoor labour to perform. It takes two to three days to make an ordinary hat, and ten to fifteen days to make a fine one. While the finer hats are being plaited, the straw is kept wet. When the plaiting is done the hat is washed and dressed, and then blocked and dried in the sun. After being worn, it may be washed and blocked again and again. The best of these hats can scarcely be distinguished from the so-called "Panama" hats, and their wearing quality is very good. There are no statistics to show the number of hats manufactured annually, but it is estimated to be between 50,000 and 100,000. The number could be largely increased, as besides the regular makers there are 460 girls who have recently been taught the art in the schools provided by the Agricultural Society of Jamaica. As two gold medals were awarded for exhibits of these hats at the recent Toronto Exhibition, and as it is announced that two Canadian firms have made arrangements to handle Jamaica hats on a large scale, this industry is likely to enjoy renewed prosperity.

CULTIVATION OF SUGAR BEET IN EUROPE.

The figures given below show the areas of land growing sugar beet in Europe at the present time as compared with those under the same cultivation last year.

In all these countries, with the exception of France, Belgium, Sweden and Roumania, the areas cultivated with sugar beet have increased this year by 181,677 hectares (448,742 English acres), or rather more than 9 per cent. over those of 1910. This is particularly noticeable in Russia, where the increase is nearly 18 per cent.

It is much to be regretted that England does not figure in this list, and that British farmers, in these times of agricultural depression (with perhaps a few exceptions), should be so backward in taking up a cultivation which the author of the paper on "Sugar-Beet Factories," recently read

	Areas in 1911.		Areas in 1910.		Percentage + or − in 1911.
	Hectares.	English Acres.	Hectares.	English Acres.	
France	225,373	556,671	228,700	564,889	− 1·4
Germany	496,837	1,227,180	473,585	1,169,753	+ 4·0
Austria-Hungary	397,200	981,084	369,700	913,159	+ 7·4
Belgium	60,800	150,176	66,100	163,267	− 8·0
Holland	55,744	137,688	49,651	122,637	+12·2
Russia	787,000	1,943,890	667,400	1,648,478	+17·9
Sweden	27,300	67,431	35,250	87,066	−22·5
Denmark	24,000	59,280	22,200	54,834	+ 8·1
Italy	60,000	148,200	41,200	101,764	+45·6
Spain	20,000	49,400	20,000	49,400	...
Roumania	12,000	29,640	13,318	32,900	− 9·9
Servia	5,300	13,091	2,970	7,336	+78·4
Bulgaria	1,700	4,199	1,700	4,199	...
Switzerland	800	1,976	600	1,482	+33·3
Totals	2,174,054	5,369,906	1,992,374	4,921,164	

before the Royal Society of Arts, termed "the life and soul, agriculturally speaking, of the north of France and Belgium." *

HOME INDUSTRIES.

An Industrial Judge.—The suggestion put forward by the President of the Master Cotton Spinners' Association, in a letter addressed to the Lord Mayor of Manchester—that a special department should be created with an advisory board composed of well-known men of the widest experience, representing both capital and labour, to whom disputes might be referred before the stage of a lock-out or a strike is reached, and over which an industrial judge, holding office permanently and independently of party politics, would preside—will be helped by the reply of the Prime Minister to a question put to him upon the matter. Mr. Asquith promised the support of the Government to "any feasible and properly-supported plan which might tend to prevent or shorten industrial warfare." There can be no difference of opinion as to the desirability of working to this end; the difficulty, of course, lies in devising a workable plan. The labour leaders appear inclined to support Sir Charles Macara's proposal, and Mr. Tom Fox, the Secretary of the British Labour Amalgamation and Lancashire and Cheshire Federation of Trades Councils, has given it as his opinion that "the great bulk of trade-union men would hail with very great satisfaction the establishment of such a court as Sir Charles Macara indicates." It would, of course, be well for both sides if such a scheme could be brought into operation. If successful, it would leave no bad blood as in many settlements made after a strike. But it is objected that it would be almost impossible to get a man with the necessary experience to act as industrial judge. How many outside men are there, for example, who understand the cotton trade? But as Mr. Thomas Ashlet, the Secretary of the Operative Spinners' Association, and one of the oldest trade-union leaders in the country, has pointed out, the judge might be appointed to act as the stipendiary magistrate does in certain cases, say in the Board of Trade shipping cases, where he has nautical and engineering assessors to assist him in technical details. The proposed judge in labour disputes, who might be an official of the Board of Trade like Mr. Askwith, or who might be appointed by the Board of Trade, could have a number of experienced men in all trades to assist him—to act as assessors, or to act like a jury. Then comes the question, should reference to such a tribunal be compulsory, and its findings final? Of course, if there was compulsion for one side there would have to be compulsion for the other—compulsion for both employer and employed. It may be that without compulsion the court would in time win the public confidence to such a degree that disputants would naturally turn to it for the settlement of their differences, but, human nature being what it is, it might also be otherwise. But at present Sir Charles Macara's proposal is little more than a suggestion. The character of the tribunal, and the powers to be conferred upon it, will invite and require full discussion before Parliament can be asked to move in the matter. Meantime, the conference to be convened by the Lord Mayor of Manchester should help to educate public opinion, and it will be a happy day for the country if discussion convinces those primarily concerned that the lock-out and the strike may be prevented by the establishment of some such tribunal for the settlement of industrial disputes as that suggested by Sir Charles Macara.

The Canadian Plan.—In considering this question, it may not be out of place to note what has been effected in Canada. In that country much good has been done by the Industrial Disputes Investigation Act. This Act prevents any strike or lock-out taking place before the matter in dispute has been considered by a board of arbitration. The dispute can be brought to early arbitration at the instance of either party, or of the Government alone. The arbitration board consists of one representative appointed by the employers, one appointed by the workmen, and a third appointed by the other two. When the board has made its decision no steps are taken to enforce it, and the parties are at liberty to proceed with a strike or lock-out if they think good. But, as a rule, the parties abide by the verdict, which usually has the irresistible weight of public opinion behind it. The Canadian Goverment states that out of 110 labour disputes that have occurred since the Act came into force in 1907, not more than ten have culminated in a strike or lock-out. The operation of the Act is highly praised in Canada.

Insurance and the Cotton Industry.—Attention was directed in these Notes last week to the excessive contributions asked from spinners and operatives by the Insurance Bill, and it was pointed out that the levy demanded from employer and employed was much in excess of the benefit offered. Since then a deputation of cotton employers has waited upon Mr. Lloyd George, and urged that the contributions demanded from them and their operatives are out of all proportion to the benefits, and that they are really helping to build up unnecessarily large reserves. Mr. Lloyd George reminded the deputation that the rates of contribution must not be judged wholly by the extent of the benefit received at the time when they are being paid; but this is not a complete justification for the rates themselves. The case for the spinners was put very forcibly by Mr. John Smethurst (Secretary of the Cotton Spinners' Federation), who has had information from thirty-three firms as to the working of the levy. These firms employ 5,782 people. The joint contributions would amount to

* *Journal*, May 12th, p. 656.

£8,031 9*s.* 2*d.*, and the sickness experience pointed to a sick benefit of £1,183 10*s*. per year, leaving a balance of £6,847 19*s.* 2*d.* He argues, basing his opinion upon actuarial reports, that the contributions of the workpeople and employers in the cotton trade should each be reduced by one penny. This would mean a reduction in the revenue expected to be received under the Bill of £250,000 a year. The scheme was able to stand this, as employers' and workpeople's contributions in eight years would be £155,577,000, while various benefits and costs of administration would amount to £127,869,000, showing a balance of £27,708,000 derived from the joint contributions of the employers and operatives alone. The reduction which the proposal would entail would amount to £2,000,000, still leaving a balance of £25,708,000.

The Packing of Wool.—The present methods of packing wool and tops was the subject of considerable discussion at the meeting of the International Congress of Woolcombers, Dealers, and Spinners, just held at Roubaix. Serious complaints were made against the system now adopted in Australia and Buenos Ayres of shipping the raw material in jute bags. It is asserted that under these conditions a great amount of loose vegetable fibre from the packing material finds its way into the wool, and as it is almost impossible to remove it during the subsequent operations, great damage ensues, every particle showing up when the goods are dyed. It was proposed that wool-growers should be acquainted with the position and advised to pack their product in paper-lined bags. It was further resolved that woolcombers be advised to adopt more stringent supervision during their processes and to take more precautions in packing tops, in order that spinners may have every assistance in their attempts to obtain cleaner raw material than is at present the case.

Scottish Motor Spirit.—The Scottish mineral oil companies continue their efforts to obtain the removal of what they consider a serious grievance. They complain of hampering Revenue restrictions. It is stated that the dutiable spirit amounts to only 1 per cent. of the whole production of the companies, and that to obtain the duty, amounting in the aggregate to between £8,000 and £9,000 per annum, 10 per cent. of the companies' total products is distilled under Revenue supervision, with all the expense and inconvenience that that entails. Nine-tenths of the spirit so distilled is used for lighting, cleaning, and as a solvent, but before any user can receive delivery of the spirit without payment of the duty he must give certain undertakings and comply with elaborate regulations regarding permits and the keeping of books. Those restrictions are a disadvantage to Scottish shale naphtha when it comes into competition with benzol made from coal-tar and other spirits. Petroleum spirit, on the other hand, is distilled abroad without any such restrictions in manufacture, and is transported in tank steamers and pumped ashore, where it comes under Revenue control for the first time. The bulk of this spirit is used for motor fuel, but it competes in other directions also with shale spirit, generally for cleaning, and necessarily has a very decided advantage from this lower cost of production due in part to freedom from restriction during distillation.

The Milk Supply.—The Report of the Royal Commission on Tuberculosis scheduled animal infection as one cause of tuberculosis, and milk from tuberculous cows is the vehicle of the infection. Much of the milk supply of this country is tuberculous, and if it is to be purified new powers of inspection and regulation are necessary. The Dairies Bill, introduced in 1909, would have given these powers, and it is hoped that it will be reintroduced and carried this Session, though, having regard to the period of the year, that seems almost too much to hope for. The Bill provides for the registration and inspection of dairies and the prohibition of the sale of tuberculous milk from an infected dairy. It is on the model of many local acts already in force, and simply makes the precautions universal. It includes provisions for the isolation, and, if necessary, the slaughter of tuberculous cattle, with compensation where equity requires it. The public health is in pressing need of some such Bill.

GENERAL NOTES.

Early Fruit and Vegetables from Italy.—Efforts are being made by shippers in Naples and Palermo to obtain a subvention from the Italian Government, in order to establish a line of quick steamers from Naples, touching at Palermo, to London. These steamers, which would be specially designed for the conveyance of early fruit and vegetables from Southern Italy and Sicily for the London market, would be provided with every convenience for the rapid loading and discharge of their cargoes, and for carrying them to their destination in perfect condition.

Proposed Optical Convention, 1912.—An executive committee has been formed for the purpose of making arrangements for the holding of an Optical Convention and Exhibition of Optical and Allied Instruments in London, in the spring or summer of 1912. The proposal has grown out of the successful Optical Convention held in the year 1905. The Convention lasted for four days; many valuable papers were read; a collection of choice and interesting instruments was brought together for the purpose of the exhibition; and the volume of proceedings produced was of notable and permanent interest. It is thought that, after

an interval of seven years, the experiment may be repeated with an assured prospect of success. The executive committee was appointed in the early part of this year, and proceeded forthwith with the necessary work of getting together a guarantee fund to provide against the expenses incidental to the holding of the Convention. Their appeal, which down to the present time has not been publicly issued, but has been addressed only to the members of the committee and to their more private friends, has been so far successful that, with the assistance of two City companies, they have already secured guarantees to the extent of £600. They think themselves warranted in expecting that when their public appeal is made a further sum of £400 at the least will be forthcoming, and they count therefore upon being able to make their preliminary arrangements upon the basis of a guarantee fund of not less than £1,000.

TRADE IN MOROCCO.—In his report on the trade of Morocco just issued (No. 4,621 Annual Series), Mr. Vice-Consul Bristow refers to the difficulties which hamper the importation of foreign goods into Morocco, and says that the extreme unpunctuality with which it is the custom to meet payments is one of the principal. This unpunctuality is largely attributable to the fluctuations in the rate of exchange. The bills drawn on the importer by the foreign merchant are almost invariably drawn "payable at the sight rate of exchange," that is to say, the importer must meet them either by means of a cheque, payable in gold, or by a payment in currency equivalent at the rate of exchange of the day to the sum due in gold. In his turn the importer quotes in gold, and thus passes the risk of exchange on to the retailer. The latter, therefore, not only charges the consumer a price in currency calculated to provide him with a sufficient margin to cover this risk, but also very frequently delays his payments to the importer until the rate of exchange is, in his opinion, most favourable, and thus prevents the importer himself from meeting his liabilities at due date.

SCARCITY OF CINNAMON IN CEYLON.—With the extension of rubber and cocoanut cultivation in Ceylon, owners of cinnamon plantations in suitable localities have found it to their advantage to root out cinnamon, and plant either rubber or cocoanuts. It hardly pays the cinnamon planter to continue cultivation of the product at existing prices, and a good many of them have substituted the more remunerative products. This is especially noticeable in the southern province, where rubber is replacing cinnamon, and in the Negombo district, where cocoanut cultivation is being extended. As a result of all this, there is a scarcity of cinnamon in the market just now. To make good the deficiency in the European market, cassia bark, imported from China, is being used as a substitute. Cassia bark is said to have a stronger and somewhat coarser flavour than cinnamon, and is coming to be much appreciated. According to the American Consul at Colombo, it is not improbable that it will swamp the cinnamon trade completely, if the cultivation of the latter is not encouraged. A rough estimate places the acreage of cinnamon cultivation in the island of Ceylon at 45,000 acres.

POTATO-ALCOHOL IN RUSSIA.—In the alcohol distilling industry of Russia potatoes are annually increasing in importance, the alcohol produced therefrom exceeding that from all other sources. Apart from the large quantities of potatoes purchased every year by the factories from peasant producers and estate owners, whenever they may have a surplus which they cannot more profitably dispose of, there are large plantations devoted solely to the production of potatoes for distilling purposes, and there is also a tendency to increase these plantations. The potato crop for 1910 was greatly in excess of that of the previous year, which was also a good one, and the quality of the tubers was in most districts better than in 1909. It is generally supposed that the climate of Russia is favourable for the production of potatoes in vast quantities, and that with the aid of fertilisers their production can be increased to meet all demands of distillation, the production of denatured spirits for industrial and illuminating purposes now being only in its infancy.

THE PRODUCTION OF MONTAN WAX IN GERMANY. —Montan wax, which in other words is miner's or bituminous wax, is exported in considerable quantities from Germany and, according to the American Consul at Hamburg, is much sought after by European, and particularly American, manufacturers. The material is obtained by the distillation of the bitumen of sulphurous brown coal, extracted by benzine, by means of superheated steam. Pure montan wax has a melting-point of 80° C., and it is an excellent substitute for ceresine, deriving its great value from its high melting-point, a quality much appreciated in the candle manufacturing industry. The utilisation of this material at the same time facilitates the working of deposits of sulphurous coal. German exports of montan-wax-bitumen and raw ozokerite in 1909 amounted to 1,289 tons, valued at £40,000, of which 147 tons went to Great Britain and 851 tons to the United States.

ANCIENT BRASSES AT EARL'S COURT. — The Queen's Palace at Earl's Court contains, among other exhibits, an interesting show, arranged by Messrs. Gawthorp and Sons, illustrative of ancient brasses. One rubbing represents the Abbot Delamere of St. Albans; the University Museum of Cambridge has lent some palimpsest fragments, and the Archæological Society of Northampton has several effigies ranging in date from 1400 to 1550. In addition to the metal work, there are some fragments of very fine fifteenth century glass, including a badge of Catherine of Arragon.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Tuesday afternoon, the 1st inst. Present:—Sir William Lee-Warner, G.C.S.I. (Chairman of the Committee), Lord Sanderson, G.C.B. (Chairman of the Council), Sir Arundel T. Arundel, K.C.S.I., Sir M. M. Bhownaggree, K.C.I.E., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., William Coldstream, B.A., Sir Steyning William Edgerley, K.C.V.O., C.I.E., James Fairbairn Finlay, C.S.I., Sir Frederic W. R. Fryer, K.C.S.I., R. A. Leslie Moore, Sir Patrick Playfair, C.I.E., Sir James Wilson, K.C.S.I., with S. Digby, C.I.E. (Secretary of the Section).

ANCIENT INDIA'S COMMERCIAL RELATIONS.*

By Jogindra Nath Samaddar, B.A., F.R.Hist.S.

I.

In the unfortunate adventure of Bhuga, son of Tugra in the Rigveda, a distinct reference is made to the fact that the singers of the Vedic hymns had heard of voyages in seas where no trace of land could be found. Mr. R. C. Dutt, in his "Civilisation in Ancient India," aptly says: "There are distinct references to voyages by sea, though of course the words used may mean rivers only." The shipwreck of Bhuga and his deliverance by the Asvins is constantly alluded to (i. 116, 3 and 4). In i. 25–7 the god Varuna [Greek Ouranos, "Uranus"] is said to know the paths of the birds through the sky and the paths of the ships over the sea. In iv. 55–6, the poet refers to the "people who, desirous to acquire wealth, pray to the sea before undertaking a voyage"; while in vii. 88, 3, Vasistha says: "When Varuna and I went on a boat and took it out to sea, I lived in the boat floating on the water and was happy in it, rocking gracefully on the waves." The Rigveda thus contains allusions which stand as a witness within India to our forefathers having been a sea-faring as well as maritime people.

Again in Manu, chapter viii. section 157, we find that interest on money lent on transport risks is to be fixed by "men well acquainted with sea voyages, or journeys by land." The historian, Mountstuart Elphinstone, is of opinion that "as the word used in the original for sea is not applicable to any inland waters, the fact may be considered as established that the Hindus navigated the ocean as early as the age of the Code."

If we place the age of Manu 900 years B.C., we shall see that even before this there were commercial relations between the East and the West. The earliest trade was by the overland route, followed by the Phœnicians along the caravan road by which they are supposed to have originally emigrated between 3000 and 2500 B.C., from the shores of the Persian Gulf to the narrow Mediterranean coast of Syria. "By it also the Eastern arts of pottery, ivory-turning, glass-making, enamelling, and wood-carving, were at last carried into the remotest recesses of Germany and Scandinavia, and profoundly influenced the primitive civilisations of those countries. The appearance among the prehistoric remains of Switzerland and Denmark of arms and implements of bronze, in succession to spear and arrow-heads of flint, generally affirmed to be due to the displacement of the primeval savage tribes of the West by the immigration of new races of a higher civilisation from the East, probably rather marks the age

* In connection with this subject, it may be worth while to refer readers of the *Journal* to the classical paper on the "Quest and Early European Settlement of India," read before the Indian Section by Sir George Birdwood (see *Journal*, Vol. xxvii., p. 192, February 7th, 1879). It takes up the history of Indian trade and commerce at the point where Mr. Samaddar leaves it.

of the earliest Phœnician intercourse with Europe; and when gradually the trade between the East and West took the routes by the Persian Gulf and the Red Sea, it still remained in the hands of the Phœnicians."

Mr. Elphinstone has also admitted that even before the age of Manu, there was intercourse with the Mediterranean countries. It cannot, however, be exactly said whether the route followed was an overland one or by sea.

In truth, the rich commodities of India had not only to be fought for in days of yore—as they are now—by all the commercial nations of ancient times, but these inspired them with a keen desire to open, as far as possible, even more and more direct channels for their transport. Among those nations the Jews stood supreme. The valuable commodities of India figured greatly in the Durbar of King Solomon. We will quote here some of the passages in the Old Testament where we find reference to these. First, in the thirty-seventh chapter of Genesis, the brethren of Joseph, when about to leave him to perish, saw a company of Ishmaelite or Midianite merchants approach, to whom they resolved to sell their brother as a slave. Dr. Vincent remarks on this passage: "Here, upon opening the oldest history in the world, we find the Ishmaelites from Gilead conducting a caravan of camels loaded with the spices of India."

Again: "And Hiram sent in the navy his servants, shipmen that had knowledge of the sea, with the servants of Solomon. And they came to Ophir, and fetched from thence gold, four hundred and twenty talents, and brought it to King Solomon" (1 Kings ix. 27, 28).

"And the navy also of Hiram, that brought gold from Ophir, brought in from Ophir great plenty of almug trees, and precious stones" (1 Kings x. 11). "Besides that he had of the merchantmen, and of all the traffick of the spice merchants, and of all the kings of Arabia, and of the governor of the country" (1 Kings x. 15). "For the king had at sea a navy of Tarshish with the navy of Hiram: Once in three years came the navy of Tarshish, bringing gold and silver, ivory and apes and peacocks" (1 Kings x. 22).

Now, the precious stones of King Hiram's cargo still lie in the hills to the west of Ajmere, rich in garnets, amethysts, chrysolites, and metals; and also in the hills of Guzerat, where agates, mocha stones and carnelians are found below the surface of the soil. Nard and Bdellium, Calamus and Cassia, were all products of India, and the Cassia of Scripture is the tamal of Sanskrit literature. Queen Esther's white and blue hangings at Persepolis were and are attributed to India, and the word *karpas*, as used in the book of Esther, is the Sanskrit name *karpasa* for the cotton plant. The Hebrew words are evidently of Indian origin; thus *kof*, "ape," is the Sanskrit word "kapi"; *thukki*, a peacock, is probably the Tamil *tokei*, and Shenhabbim, "ivory," is explained by Gesenius as a contraction for *Shen-a-hibbim*, the latter part being the Sanskrit word *ibha*, an elephant, with the Hebrew article prefixed. The names of products, as Professor Lassen remarks, are not the only Sanskrit words early introduced into Hebrew by the means of trade, and the inference is that the "Ophir" of Scripture must have been in India, and probably on the Malabar coast. In all probability, Indian navigators shipped the goods from the Indus to some part to the south of Bombay, whence they were fetched by the Arabs or Phœnicians.

When Nebuchadnezzar destroyed the Jewish Government *circa* 588 B.C., some of the Jewish merchants accompanied him to Babylon, and carried on their commercial pursuits there. Nebuchadnezzar was a patron of commerce, and the Jewish merchants became very rich, as the constant intercourse which subsisted at this period between Babylon and the principal parts of Hindustan afforded them the means of participating in the lucrative commerce of India. Thus a close connection grew up between Assyria and Persia and Syria, and the Jewish merchants settled in some of the towns of these countries and carried on trade with the Malabar coast. It is possible that constant intercourse made some of these men settle in Malabar. No definite date can be assigned when they began to settle in Malabar, but from the copper-plates which are still available in the synagogues at Malabar on which there are inscriptions, we can surmise that they came about the close of the reign of Nebuchadnezzar—that is, some 600 years before the birth of Christ. From the inscriptions, it transpires that the Jewish merchants were well received by the Zamorin, that in numerical strength they exceeded two thousand, and could freely indulge in the exercise of their religion. They bought land and built a synagogue there, and appointed one of themselves to govern their colony.

From Homer, we come to know that the celebrated bed of King Menelaus, the brother of Agamemnon, was carved from the tusks of Indian elephants. The genealogy of the words for ivory and elephant is said to prove that

Greece got ivory from India. There was no word in Greek for elephant, and when Herodotus, "the father of History," saw an elephant he called it ivory, using the Sanskrit-derived word by which the tusks were known in commerce. From the references in Greek literature we are led to suppose that our ancestors confined themselves to river-borne trade. But these Grecian authors admit that shipbuilding was in vogue. Arrian, in speaking of the castes of India says: "Of this class (*i.e.*, the fourth) are the shipbuilders and the sailors, as many as navigate the river." Thus we find a reference to the "rivers," but not to the "sea." Nearchus, the naval commander of Alexander the Great, did not perceive, save fishing-boats, any large-sized boats from the Indus to the Euphrates. Even in the Indus he did not find many boats. The ships of Alexander he had to prepare with his own men, and to man them with men from the shores of the Mediterranean Sea. We shall discuss this statement of Nearchus as we proceed.

Whatever might or might not be the effects of Alexander's invasion, there is no denying the fact that the invasion opened up new trade routes and vistas. Mr. Beveridge truly remarks: "Such exploits, once deemed the only avenues of fame, are now judged more easily. Still it is impossible to deny that conquerors were often in early times pioneers of civilisation, commerce following peacefully along this bloody track and compensating for their devastation by the blessing which it diffused. Such was certainly the result of the Indian expedition of Alexander; and therefore, while reprobating the motives in which it originated, we cannot but rejoice that it was so overruled by Providence as to be productive of most important valuable results."

Exactly so. That a closer commercial connection grew up between India and the West is evidenced by the fact of the coming of Megasthenes; and of Bindusara, the son and successor of Chandragupta [Sandracottus] asking for figs and raisin wine, and requesting King Antiochus "to buy and send him a professor!" Megasthenes also speaks of the ports of India; while a contemporary manuscript, recently brought to light and translated into English by Pundit R. Shamshastry, Librarian of the Government Oriental Library, Mysore, and into Bengali by the writer of this article, lays down precise rules for the conduct of the trade between India and the West. In Book II., chapter xvi., the duties of the superintendent of commerce are laid down, in which the following passage occurs:

"The superintendent shall show favour to those who import foreign merchandise: Mariners (*navika*) and merchants who import foreign merchandise, shall be favoured with remission of trade taxes so that they may derive some profit. Foreigners importing merchandise shall be exempted from being sued for debts unless they are (local) association and partners."

As regards the sale of the king's merchandise, in foreign countries, Chanakya, also known by the name of Kautilya, lays down the following rule. The passage is a long one, but as the book is a rare one we crave indulgence of the readers to reproduce it fully.

"Having ascertained the value of the local produce as compared with that of foreign produce that can be obtained in barter, the superintendent will find out whether there is any margin left for profit after meeting the payments (to the foreign king) such as the toll, road-cess, etc., etc., and the portion of merchandise payable to the foreign king. If no profit can be realised by selling the local produce in foreign countries, he has to consider whether any local produce can be profitably bartered for any foreign produce. Or he may take his merchandise to other countries through rivers. Having gathered information as to the transaction in commercial towns along the banks of rivers, he shall transport his merchandise to profitable markets."

Again, in chapter xxviii. the superintendent of ships is enjoined "to examine the accounts relating to navigation not only on oceans and mouths of rivers, but also on lakes, natural or artificial, and rivers in the vicinity, etc." In the fourth book, second chapter, the superintendent of commerce is directed to fix a profit of 5 per cent. over and above the fixed price of local commodities and 10 per cent. on foreign produce.

We can surmise that Kautilya would not have indulged in these minute instructions had not commerce been in a flourishing state. In fact, we come across the names of many ports on the Son and the Ganges, and even now traces are found of a stone embankment on the River Son. As things really stood, we are tempted to agree with the view of Mr. Elphinstone that "it is probable that at the same time when Nearchus saw little sign of commerce on the Indus, the Ganges may have been covered with boats."

Turning now to the second century before Christ, we see from Agatharchides that there was commercial connection with the west coast of India and the countries to the West, and this author expressly mentions that ships went from India to the ports of Sabaea. Passing

over two centuries, we obtain clear accounts of this trade by reading "The Periplus of the Erythraean Sea." The author has left us a clear description of the coast of India, from the Indus round Cape Comorin to a point high up on the coast of Coromandel. We gather that the ships from India continued to cross the mouth of the Persian Gulf and from the shores of Arabia to the mouth of the Red Sea, and the Egyptian Greeks used to quit the coast soon after leaving the Red Sea, and then stretch across the Indian Ocean to the coast of Malabar The Periplus describes the Indians as actively engaged in the traffic on their own coast. "There were boats at the Indus to receive the cargoes of the ships which were unable to enter the river on account of the bar at its mouth; fishing boats were kept in employ near the opening of the Gulf of Cambay to pilot vessels coming to Baroach." Large vessels crossed the Bay of Bengal to the Ganges and Sumatra and Java. Thus we find in the histories of Java that a body of Hindus from Calinga went to Java possibly by the end of the first century B.C. From Fa-hian and Hiewn Tsang also we find that the Indians of those ages used to indulge in maritime enterprises.

II.

We referred in the first part of this article to the Phœnicians. There was always a close commercial connection with Syria and Egypt. The direct commercial relations with India and Syria ceased with the conquest of Syria by the Roman Emperor Aurelius. But the connection with Egypt and Greece *via* Alexandria was becoming closer day by day, and the Ptolemies gave great encouragement to commerce. The ancient history of the Egyptians says:

"Ptolemy II. (Philadelphus) thought it necessary to found a city on the western shore of the Red Sea, whence the ships were to sail. He accordingly built one on the Gulf called Immundus, and to this day "Foul Bay," and he gave it the name of his mother Berenice. The treasures of Arabia, India, Persia and Ethiopia, were landed, and from thence they were carried on camels to Coptos, where they were again shipped and brought down the Nile to Alexandria, which transmitted them to all the West in exchange for merchandise afterwards exported to the East."

Thirty years before the birth of Christ, when the Emperor Augustus conquered Egypt, this flourishing commerce fell into the hands of the Romans. The Romans were hitherto enjoying the luxuries of the East in a roundabout way, but now that the very emporium fell into their own hands they began to employ their wonted energy, with the result that a fleet was prepared for trading with the East and a closer commercial relation grew up between Rome and India. The spirit of adventure grew up day by day, and, forsaking the old circuitous route, they began to sail from the coast of the Babel-mandeb, and come direct to Malabar and Guzerat by sea. The mariner Hippaulans noticed the directions of the monsoon and began to sail by this way. The result was that the journey now took half the time than it used to take before.

From this time, till the fall of the Western Empire, there was constant exchange of commodities. Every year a fleet of 120 ships sailed from Myos Hormos and came to Mousiris Emporion and Bakarei on the Malabar coast, and thence sailed to Ceylon. Ceylon then was a great emporium, and merchants of Bengal, Orrisa and Karnat (the present Carnatic), used to come there and exchange commodities. The Romans used to buy our goods in exchange for gold and silver and having completed their purchases this fleet of 120 ships used to return home. Generally they left Ceylon in December or in January, and silk, muslin, spices and essences, as well as pearls and other valuable stones, used to leave our shores in this way. This exchange of Indian commodities for gold and silver is fully corroborated by Mr. Vincent Smith in his history of India (1st Edition, p. 337).

Roman gold coins of the early Empire have been discovered in such large quantities in Southern India that it is apparent that they served for the gold currency of the peninsula. Five coolie loads were found as late as in 1851 near Cannanore on the Malabar coast, mostly belonging to the mintage of Tiberius and Nero; and many other large loads of Roman coins, gold, silver and copper, have been discovered in various localities from time to time.

Mr. Vincent Smith truly remarks that "it is certain that the Pandya State, during the early centuries of the Christian Era, shared along with the Chera kingdom of Malabar a very remunerative trade with the Roman Empire." Pliny has justly said, in writing of the commercial relations with India, that "amidst the rude ignorance which characterised the Middle Ages in Europe, the commerce with India served to soften and instruct those nations who participated in it; and in modern times it fostered that spirit of enterprise which was destined to render navigation subservient to philosophy and knowledge,

by making the inhabitants of far distant countries acquainted with each other, and by familiarising their minds with the various habitudes and customs that diversify human life."

Even as late as A.D. 400 coins of Arcadius and Honorius of the smallest value have been found in considerable numbers at Madura, and suggestions have been made that there might have been even a Roman colony there. At anyrate, Rome and India were then in the closest ties of commercial friendship.

When the capital was removed to Constantinople in 324, the Western Empire declined, and the trade through Egypt and the Red Sea ceased altogether. The merchants of Alexandria were becoming too luxurious day by day, and simultaneously the craving for commerce came on the Arabs. The Arabs were already proficient in navigation, and the energy which they received now through the propagation of Islamism, infused a new spirit amongst this hardy nation. Actuated by an irresistible impulse to convert all, they were eager to go to fresh lands to propagate their new religion. As an outcome, commercial relations were established by trading. A fleet of ships expressly manned to trade with India began to come year after year, and the Arabians began to settle on the coast of Malabar. It is even said that to smooth their commercial way they converted the Zamorin, who was induced by the Dervishes to go on a pilgrimage to Mecca. Thus the Arabian commerce thrived. The Egyptians, forgetting their own interest, and being able to procure Indian commodities at less trouble, though at greater cost, through the Arabians and Persians, refrained altogether from continuing their relations with the Indian ports.

The Persians were at first averse from maritime enterprise, but, learning from Indian merchants the route from the Persian Gulf to the Malabar coast, they began to send ships to different ports in the Malabar coast. They either used to exchange their own commodities or buy Indian commodities with money. The time taken up for a single voyage was at an average ten weeks. When the goods reached the Euphrates, they were carried by boats to Assyria and Mesopotamia, and, as the people of Constantinople could get Indian products without the risk and troubles incidental to adventurous voyages, the desire to indulge in commercial pursuit began to die in them.

It was for these reasons that the Persians and the Arabs made a monopoly of Indian commerce in the seventh century A.D., but, as the Persians possessed many natural advantages, they began to predominate over the Arabians, and soon the Persians altogether monopolised the silk trade of the East. As a war broke out between the Persian King and the Emperor of Constantinople, the China silk which used to reach Greece through Tartary was also stopped, and the Persians began to charge exorbitant rates for these silks. The Emperor Justinian tried to remedy this evil, but for a long time was unsuccessful. At last Providence found out a way. Two monks, who had come to China and India for preaching the Gospel, had seen the rearing of silkworms and the manufacture of silk. They, in the course of conversation with Justinian, spoke of this, and the Emperor urged on these monks to return and learn fully the art of manufacture of silk. They spent a few years in China, and, having learnt fully the art, took in a hollow cane a few worms and went back to Constantinople. These worms were placed on dung and, when hatched, were fed with mulberry leaves. The hopes of the Emperor were fulfilled, and manufactories were established in some of the Grecian islands. Thus the export of silk from China and India to Rome stopped altogether, but other commodities still found their market in Greece in the following centuries.

We have already said that the new religion of Mahomet invigorated and gave a new life to his followers. After the death of the Prophet, Omar conquered Persia and gave his religion to the Persians and established the Caliphate. With Persia the Indian trade also fell into the hands of the Mohammedans. The Caliph, in order to encourage commerce, established a port at Basora which became soon an important mart, and finding Indian trade very advantageous the Mohammedans intended to introduce Indian commodities into Syria. When Egypt and Syria fell into the hands of the Caliph, the Alexandrine merchants were prohibited from trading with Byzantine kindgoms, and as there was constant warfare with Mohammedans and the Greeks, the latter, as well as the Italians, were deprived of Indian commodities.

Those Roman monks who had carried silkworms in their canes knew that Amal and Archenzi (modern Archenzed) on the Oxus were also marts for Indian and Chinese goods. Some of the adventurous merchants of Constantinople sent their agents to these ports, and they managed to send commodities through the Caspian Sea and the River Cyrus. Here they were embarked and then conveyed by land to some distance, and thence again by the Black Sea, ultimately

reaching Constantinople. The Mohammedans at this time were very powerful. They established a colony at Malabar and had commercial relations with Bengal, Siam, and China. Greece and Rome viewed with great jealousy the rise of this Mohammedan power.

Venice had from the middle of the fifth century established commercial connection with Alexandria and Constantinople, and by the middle of the sixth century had imported silks from India and China. From the beginning of the ninth century spices, medicines, and silk of India used to reach the marts of Venice, which began to hoard wealth and to grow rich by this Indian commerce. At the end of the Crusades, amicable relations having been established between the Christians and the Mohammedans, the route through Egypt was reopened and thus commodities again began to reach the continent of Europe.

Even before Venice, Genoa had enjoyed to a small extent Indian commodities, and when Venice and Genoa were each thwarting the other, Florence was rising under the Medicis. Under the fostering care of the Medicis, the Florentines began to trade with the East and commerce thrived. When Egypt and Syria were conquered by Selim, Venice forsook her neighbours, and gradually, when Cyprus fell into her hands, she made a monopoly of the Eastern trade and Cyprus soon became an emporium. The fall of Constantinople ruined the Genoese trade with the East by the Black Sea, but the discovery of the passage to India by the Cape of Good Hope gradually undermined the Venetian trade by Alexandria.

The Portuguese were the first who explored the South Atlantic coasts of Africa, and by their discovery they opened up to the nations of Europe the sea-way through the Indian archipelago. We are all familiar with the subsequent events, and we need not go into them.

III.

We shall now discuss the routes which were followed by merchants in coming in and going out of India. By the overland route merchants could go to Bactria by the north-west passage. Thence they went to Balk, where they spent some time in marketing, and after that to Babylon, where Indian commodities were highly valued. From the shores of the Caspian Sea the goods were then despatched in ships, and after that, by a land route and the Black Sea, they reached the Mediterranean Sea. From Babylon they passed to Palmyra and thence to the Levant, where Indian commodities had a ready sale. Generally, European goods were exchanged for Arabian and Indian goods in these places. The route was an adventurous one, the commodities being generally borne by camels. As soon as the water route was discovered, this came to be abandoned.

When the Phœnicians were engaged in this profitable commerce they used to send goods to Tyre *via* certain ports on the Red Sea. This, too, was of considerable disadvantage. When they became possessed of Rioncula on the Mediterranean Sea, they used to carry Indian goods to the Red Sea, whence they were borne some distance by land, reshipped, and thus reached Tyre. Although goods had to be shipped over twice, this was found of greater advantage than the overland route. When Tyre was destroyed by Alexander in 322 B.C., Alexandria was founded by him, and as thus a fresh opening was made, for nearly eighteen centuries goods were despatched by this route. Alexander personally recommended this route, but he could not live long enough to carry out his projects. Immediately after his death, Ptolemy Lagos ascended the throne, and a lighthouse (which was then considered as one of the seven wonders of the world) was built by him at considerable expense. His son, Ptolemy Philadelphus, tried to cut a canal through the Isthmus of Suez, but, failing to do this, founded a town, as above stated, on the coast of the Red Sea.

As long as Egypt remained independent, this route was followed. European manufactures used to come to Berenice and thence were taken to the ports on the Arabian Sea and Persian Gulf, and so on to the Indus. The merchants did not confine themselves to the towns on the Indus, and in all probability all the ports of the coast line were also utilised. To make a monopoly of this lucrative trade, the kings of Egypt kept ready a strong fleet, both merchantmen and men-of-war. Even when the Romans conquered Egypt this route was followed.

From the Periplus we know that muslin, various kinds of chintz, silk threads, indigo and other colours, cinnamon and other spices, sugar, diamonds, pearls, steel, medicines, scents, and occasionally slave-girls, also were exported from India.

Many of the commodities mentioned in the Periplus formed, and form now, the staple exports of India. Sir George Birdwood in the *Journal of the Society of Arts*, February 7th, 1879, wrote that "the history of modern Europe, and emphatically of England, has been the

quest of the aromatic gum-resins and balsams and condiments and spices, of India and the Indian archipelago." Abbé Renaudot in his "Anciennes Relations des Indes et de la Chine" (1718), writing of two Arab merchants who travelled in the ninth and tenth centuries in India, says that India then exported tea, porcelain, spirits and rice.

Edrisi, the Nubian geographer, speaks of the fine threads of the Coromandel coast, chillies and spices of Malabar, camphor of Sumatra and lemons of Hyderabad (1099–1186). Benjamin of Tudela, travelling in India in the twelfth century, speaks of India's exporting silk cloth, pulses and spices. He also writes of cinnamon, ginger and other sorts of spices as found in abundance in South India. Ibou Batuta, the well-known traveller, writes of aloes, camphor, sandal-wood, jambolin, mangoes, oranges, some of which were exported. The Venetian nobleman, Marino Samito, came to the East some time early in the fourteenth century. He writes of various spices being exported from India. The Genoese traveller, Hieronimo di Santo Stefano, coming to India in the end of the fifteenth century, speaks of garnet, jacinth, cats'-eye, and various sorts of spices which had a ready market. Ludovico di Varthema wrote that 300 ships of other countries used in his time [16th century] to come to India. Lastly, the letter which the Zamorin of Calicut wrote to the King of Portugal clearly speaks of the export of India:—"Vasco de Gama, a nobleman of your household, has visited my kingdom and has given me great pleasure. In my kingdom, there is abundance of cinnamon, cloves, ginger, pepper and precious stones in great quantities. What I ask from thy country is gold, silver, coral and scarlet."

"Southern India had the good fortune to possess three precious commodities not procurable elsewhere, namely pepper, pearls and beryls. Pepper fetched an enormous price in the markets of Europe, and was so highly prized, that when Alaric the Goth levied his war indemnity from Rome in A.D. 409 his terms included the delivery of 3,000 pounds of pepper." In Gibbon, chapter xxxi., we find the following:—"Pepper was a favourite ingredient of the most expensive Roman cookery, and the best sort commonly sold for fifteen denarii, or ten shillings the pound."

The pearl fishery of the south is referred to by Mr. Sewel in the *Journal of the Royal Asiatic Society*, 1904. Mr. Vincent Smith in the admirable "History of India," also says: "The pearl fishery of the southern sea, which still is productive and valuable, had been worked for untold ages, and always attracted a crowd of foreign merchants. The mines of Padiyur in the Coimbator district were almost the only source known to the ancient world from which good beryls could be obtained and a few gems, more esteemed by both Indians and Romans."

In an article on "Roman Coins found in India," Mr. Sewel, in the *Journal of the Royal Asiatic Society*, speaks of the Roman coins which circulated in southern India freely, and Roman bronze small change, partly imported and partly minted at Madura, was commonly used in the bazaars. So much connection grew up with Rome and the south of India, that "considerable colonies of Roman subjects engaged in trade were settled in southern India during the first two centuries; while the beautiful large ships of the Yarns' lay off Mousiris, to receive the cargoes of pepper paid for by Roman gold."

The Tamil poems speak of the importation of Yavana wines, lamps and vases into Southern India; and their testimony is confirmed by the discovery in the Nilgiri megalithic tombs of numerous bronze vessels similar to those known to have been produced in Europe during the early centuries of the Christian Era. And again:—"The Tamil States maintained powerful navies and were visited freely by ships, from both East and West, which brought merchants of various races, eager to buy the pearls, pepper, beryls and other choice commodities of India, and to pay for them with the gold, silver, and art ware of Europe."

Looking-glasses formed an important item in the goods for presentation to the Moghul Emperors by the foreign merchants. For an account of Justinian's efforts to introduce silkworms into the West, and the general commercial connection of Rome with India, see Gibbon's "Decline and Fall of the Roman Empire," chapter xli.

THE HOUSING QUESTION IN BOMBAY.

In the course of his speech introducing the Indian Budget in the House of Commons on July 26th, Mr. Montagu, the Under-Secretary of State for India, made some interesting remarks on the housing question in Bombay, in the course of which he quoted from the paper on this subject read before the Indian Section of the Society last year by Mr. G. Owen W. Dunn. "Technical instruction," said Mr. Montagu, "in special trades and occupations is impossible in sparsely populated districts. But, on the other hand, there is danger that all the evils of town life—the overcrowding,

the destitution, and all the squalid misery of mean streets with which we are too familiar—may be reproduced in India, and be even harder to bear than here on account of the suffocating heat. Already we hear of overcrowding and insanitary tenements in the operatives' quarters in Bombay. Mr. Dunn, late Chairman of the Bombay City Improvement Trust, in a paper of February 17th, 1910, says :—

"'The rooms or "chals," less than ten feet square, are separated from one another by partitions of wood or split bamboos, plastered with mud. There is no ceiling, only the sloping low roof, which is of rough round rafters, and a single thickness of country tiles. The walls and roof are black with smoke and dirt of many years; the rooms are filled with choking smoke from the wood fires and naked lamps, and there is no exit for this except through the rough doors. The only openings are the doors leading from the rooms on to narrow verandahs, no ventilation, darkness, and a choking atmosphere, and a family of five or six persons, with perhaps a lodger or two. Refuse of all kinds is disposed of by the simple expedient of throwing it outside beyond the verandah, and the condition of the surroundings of the "chal" may be left to the imagination.'

"In Bombay a city improvement trust has been working for the last ten years with inadequate means. The Government of India have now given, as I have said, £333,000 to it, and proposals are being considered for providing the trust with a larger income from local sources. A similar trust is now about to be created in Calcutta. In Rangoon, again, land reclamation on a large scale is being undertaken. Elsewhere much attention is being paid to the subject but the most urgent need is the education of the masses in the principles of hygiene. There is a limitless field, indeed, for private enterprise here. Tolerable though archaic habits and practices may be in the open country, when transferred to the crowded town they become unsupportable. If there were less ignorance and less perversity, plague would never find in the country the lodgment that it has. It is an established fact that persons living under proper sanitary conditions are virtually exempt from the disease. Plague does not attack the gaol population or the native army; it attacks the ordinary civil population, because they live in houses which are not rat proof, because they treat the rat almost as a domestic animal, because large numbers of them refuse to trap or kill it, and because they will not adopt the sanitary precautions which are pressed upon them."

ARTS AND CRAFTS.

The Board of Education Circular.—From the circular of the Board of Education on the subject of art education generally, and more particularly of the national competition and other examinations (of which extracts were printed in the *Journal* of July 21st), it is apparent that the Board has in view some very radical measures of reform.

In the first place inspection is in the future to take the place of the more elementary examinations. And on this subject it may be as well to say a few words. Some of the teachers are under the impression that the proposal is to abolish examinations altogether and substitute inspection for them, whereas what the circular explicitly proposes to do, for the moment at any rate, is to put an end to "the elementary examinations now conducted by" the Board "as well as the minute subdivision of art studies for examination purposes, and to substitute examinations of a more comprehensive character adapted to the needs of students who have reached a fairly advanced level in their studies."

In the second place, the existing tests for Art Class Teachers' and Art Masters' certificates will be brought to an end in 1912 and new regulations will be issued.

Thirdly, some experienced head masters of schools of art and others are to be invited to consult with the Board as to the lines upon which a reformed National Competition can best be established.

Finally, with a view to considering how the new policy and the reforms generally can best be carried out, it is proposed to establish a standing Committee of Advice for Education in Art for a term of three years from September 1st, 1911.

The Board's proposals are naturally rather tentative at present, but they are all in the right direction. For years past thousands of students have sat for examinations so elementary in character that the judging of the work by artists of standing has really been sheer waste of time; and if the stoppage of these elementary tests creates a few difficulties, there is no reason why in a year or two's time they should not all be overcome. The present method of examination for teachers' certificates has for years been considered unsatisfactory by teachers of the most different schools of thought, and everyone will welcome a change in the regulations in regard to them. It is satisfactory to note that the new scheme proposes to make some provision for testing the teaching powers of candidates. Is it too much to hope that the necessity at the present time of providing equally well trained teachers for all types of schools—schools of art, secondary schools and some of the larger primary schools—will be recognised? As to National Competition, it has served its purpose well, and it would be a great mistake to abolish it without putting something else in its place, or to give up the annual exhibition of the best work of the best students, but there has been for some time past too much show work executed especially for the competition; and the rapid growth of craft exhibits in recent years, and the absence of a set plan of making awards for craftsmanship or design, has made the judging some-

what confusing both for examiners and students. It has sometimes been difficult to know whether design, or craftsmanship, or both, or only some undefined sort of "charm" was the determining factor for which the prize could be said to be given. Many teachers are saying that the Board's proposals are very vague, and some are complaining of certain parts of the scheme; but there appears to be a very widespread feeling that the proposed changes are for the most part quite on the right lines.

When we turn to the composition of the Standing Committee the position seems to be, from the point of view of Arts and Crafts, a good deal less satisfactory. Its members include two or three officials, three prominent head masters, four painters, and a few business men (some of them connected with manufactures into which art enters largely, and one a member of a prominent shipping firm). But there is only one architect on the list, and Professor Selwyn Image, whose exquisite taste no one could doubt, but who would be the last person to consider himself an expert trade designer, is the only man who can be said in any way to represent design. It is true that the Director of the Victoria and Albert Museum has a seat, but when one thinks for a moment of Sir Cecil Smith as the former Keeper of the Greek and Roman Antiquities at the British Museum, one realises that, whatever his qualifications in other directions may be, he is hardly likely to be well versed in industrial design. The circular states that the chief examiners in painting and modelling, and the visitor for sculpture and modelling, who are not yet appointed, will be added to the committee—but it does not so much as hint at the possibility of the appointment of a designer. There will thus be five painters (without counting Sir Charles Holroyd, who sits as Director of the National Gallery) and two modellers on the committee, and only one architect and one designer. No one doubts the importance of painting; but for the purpose in hand, and in view of the work before the committee, and the growing importance of trade and technical schools, the number of painters, as compared with other kinds of artists, seems altogether out of proportion.

Works by L.C.C. Scholarship and Exhibition Holders.—A selection of the works entered in competition for the various art and artisan scholarships and exhibitions, offered by the London County Council, was on view for a couple of days this month at the Central School of Arts and Crafts, and was, as this little exhibition always is, very well worth a visit. The show was carefully arranged, and the exhibits as a whole were quite interesting, but it does seem a pity that the authorities do not see their way to giving a little information as to the various schools from which the different works come. It is easy to see that, just at this particular stage in his career, it might not be the best thing for the student gaining, say, an artisan scholarship, that his name should be brought too prominently before the public, but there seems no adequate reason for withholding the name of the school in which he has been trained—and to the majority of those who visit the exhibition its value would be materially increased if they could not merely see what is being done in London, but could learn at which schools the best teaching of various classes is being given. It is true that the officials in charge are courteously ready to answer questions, but they do not themselves appear to know always from which schools the exhibits come, and the ordinary visitor has some hesitation in asking an unlimited number of questions.

This year's exhibits show very plainly how quickly fashions change. Jewellery, which some years back was one of the best represented subjects, is this year responsible for so few examples that it can hardly be seriously said to count; and cabinet-work, which a short time ago occupied a considerable amount of space, is much less in evidence than in former years, though there is a little collection of carving, and some of the pieces are very well and cleanly cut. Book illustration, again, is by no means so conspicuous as it has been in past years, and the few designs for bindings, casings and wrappers are anything but satisfactory. Typography has been coming to the fore of late, and some of the work shown this year is extremely well set out and spaced with a good deal of care and taste. The tooled book covers, on the other hand, though generally good in workmanship, seldom show much appreciation of the best way to treat the space at the student's disposal, or a very clear understanding of the value to be got, even in the most elaborate work, by leaving a certain amount of plain ground. There is some quite excellent lettering both for painting and carving, though the one advertisement shown is lacking in attractive power. The script, too, was some of it very good, but the little ornaments filling up the ends of the lines were often quite futile. There was a fair show of museum studies and some drawings from nature, and one very good repeating pattern; but taken as a whole the designs for manufacture formed a very poor show, and the habit of sending them up for examination with no indication of the repeat, though it may make them look rather tidier, does not show a very workmanlike understanding of the best way of presenting an allover repeating pattern. The larger metalwork, of which a very fair amount was on view, is eminently serious in character, and is generally good both in technique and in form. Of embroidery there was a very large exhibit; some of the work was very well executed and a little of it (which looked as though it all came from one school) showed a remarkably good and fearless sense of colour. On the whole, however, there was a good deal of sameness in design and treatment about the work, and anything like boldness in design was conspicuous by its absence. This same want of boldness characterised the workmanship also. Much of the stitchery is really very fine, but it does not seem to have occurred to the students that in artistic

needlework it is at least as important to preserve the lines of the drawing and the sweetness of the curves as to take small stitches.

There are no very remarkable features differentiating this year's exhibition from those which have gone before, but the general level of technical accomplishment seems to be rather higher than it used to be.

EMPIRE NOTES.

An Imperial Council of Commerce.—A very important proposal emanating from the Congress of Chambers of Commerce of the Empire, held in Sydney, New South Wales, last year, has found expression in a meeting held last month, at the instance of the London Chamber of Commerce, on the subject of forming an Imperial Chamber or Council of Commerce, with headquarters in London. The proposal had been endorsed by the Associated Chambers of Commerce, at their meetings in London in March last, and carried with it, therefore, the active approval of all the Chambers represented by that Association. The objects of the new Council are stated to be:—To increase the inter-Imperial trade interests of the Empire; to collect and distribute Imperial commercial intelligence amongst different chambers; to focus and distribute reliable information as to each country's needs and powers; and to act as an Imperial clearing house for commercial information and suggestions. The chairman of the meeting stated that the London Chamber of Commerce was prepared, for the first three years at any rate, to provide officers and staff, and to raise the necessary funds. Resolutions approving the formation of the Council and confirming the existing Congress Organizing Committee, with its officers, under the title of the British Imperial Council of Commerce were adopted, and the opinion was expressed that the establishment of such a Council was a movement of world-wide importance. This opinion will certainly be endorsed, and that most cordially, by the members of a society like this, one of whose chief objects is "the Encouragement of Commerce," and not only of commerce as it affects the home manufacturer, merchant, and trader, but as it affects all the business men of our Empire beyond the seas.

An Ontario Rolling-Stock Enterprise.—A company has just been formed in Ontario for the manufacture of rolling-stock for railways and tramways, with a capital of a million dollars (£205,479). There is said to be a good field for a concern of this kind in Canada, where transport facilities are being rapidly extended in all directions. Many new tramway services, also, are likely to be established in the Dominion during the next few years. Regina (Alta) is having the cars for the tramway service, about to be started there, built in England, which, it is alleged, would have been made in Canada if works of the kind now projected had been established. Other industrial developments are being promoted in Ontario; one of them is the erection of a large flour mill on the Lachine Canal, the capital of which is also to be a million dollars. The creation of these new industries is a further indication of the intention of our Canadian fellow-subjects to make their country independent of the manufacturers of the Motherland, and emphasises the necessity, to which attention has frequently been called in this column, of home capitalists and leading manufacturers giving heed to the openings for their capital and enterprise in our oversea Dominions.

Siberian Alfalfa in Saskatchewan.—One of the problems which the Canadian farmer of the North-West has to solve is the provision of winter fodder for his cattle, as there are no indigenous grasses which can be cultivated in the northern provinces suitable for the purpose. The Saskatoon Board of Trade, therefore, has just secured several hundred one-year-old plants of the Siberian alfalfa, as, in the opinion of Professor N. E. Hansen, of the United States Agricultural Department, the alfalfa may be grown right up to the Arctic circle. Professor Hansen was sent by his Government on a tour of investigation in Siberia, and has recently returned, bringing with him a large number of alfalfa plants, some of which, as stated above, the Saskatoon Board of Trade has acquired. If, as it is hoped, this valuable grass will grow in the north-west of Canada, land which is now practically useless may be made worth £20 an acre.

Western Australian Caves: a New Discovery.—The limestone caves of Western Australia, discovered on the south-west coast some years ago, have proved a great attraction to that part of the country, and are regarded as second only in beauty to the Jenolan caves of New South Wales. But, according to the report of a further discovery recently made, the Jenolan Caves may take a second place. Referring to the Moondine Cave, found near Karridale, a few miles from the south-west coast, the Colonial Secretary says: "I have seen all the other caves in Western Australia, and also the well-known Jenolan Caves of New South Wales, but I say without hesitation that the Moondine, which is to be known in future as the Coronation Cave, far excels the whole of them. After four hours' exploration, two large beautiful chambers, which it is proposed to call King George and Queen Mary respectively, were discovered. Each of them is far superior in beauty to any cavern in Australia. I am certain from the conformation of the country that the cave will be found to contain still more beautiful chambers."

Australian Irrigation Areas.—Dr. Elwood Mead, who last year visited this country in the interests of the Victoria irrigation schemes, and for the purpose of securing settlers, has just issued a report on the northern Murrumbidgee district, New South Wales, in which he says that when the plans are completed for irrigating the 350,000 out of the 1,344,000 acres comprising that

district, 200,000 people will be able to live in comfort, where at present there are only a few landowners and stockmen. To make this land ready for settlement will require the building of about 2,000 miles of canals and ditches. An equal mileage of roads will be needed, and about 10,000 farmhouses must be erected by the settlers, or by the Government on their behalf. Dr. Mead strongly recommends the building of these houses, the fencing of the land, and the clearing and ploughing of a few acres of the various holdings, as nothing, he thinks, can be more attractive to the intending settler than to know he has a small ready-made farm to which to go. The money necessary for this purpose will be provided by the Government, who are prepared to extend the time of repayment so as to meet the requirements of men with small capital.

New Zealand's Homes for Workers.—To meet the needs of the working population of the Dominion, the Government are about to start their Workers' Home Scheme. The architect of the Labour Department has therefore prepared eighteen designs, representing houses ranging in cost from £120 for two rooms, up to £620 for eight rooms. Four or five-room cottages have been designed, costing from £255 to £325. Copies of the plans and descriptions of these houses have been sent to all the principal post offices, where they may be inspected by applicants, and, in the event of any particular design being selected, the applicant is supplied with the necessary plan and specification free. The maximum amount which the department is prepared to advance, in any one case, is £450. In view of the house-planning schemes which are now so numerous and so popular in this country, it is interesting to mark the progress which is being made in this direction, in his Majesty's Dominions overseas. It is to be hoped, however, that in the Colonies, as well as at home, the designs selected may have some artistic merit, and that everything may not be sacrificed to cheapness.

The Timber Resources of Papua.—Reference has on several occasions been made in these columns to the great natural resources of Papua, of which timber is so important a part. Samples of six selected Papuan woods were sent some months ago to be tested at the Melbourne University Engineering School. A report of their tests has just been issued, in which it is stated that the Uloba is found to be a strong and durable wood, capable of resisting the termite (the white ant) but not the teredo navalis (the well-known sea worm). In this respect it differs from some of the Australian eucalypts, which can resist the teredo but not the white ant, though it resembles other eucalypts which can resist the white ant but not the teredo. The eucalyptus marginata (Jarrah) of Western Australia, however, in certain conditions, can resist both. Uloba is said to have excellent bending strength, and will therefore be specially useful for building purposes. The Kokoilo, which is a light and cedar-like wood, is not durable in damp positions, but may be useful for panels, as a substitute for cedar. Its bending strength is also good. The Alaga is a fairly durable, close-grained wood, with fair bending strength. The Tamanau is described as moderately durable, medium-grained, and light pink in colour, but with poor bending strength. The Madave is coarse-grained, with moderate bending strength, and is not durable in damp positions. The sixth sample tested, the Ilimo, is soft and rather open-grained. Laboratory tests of this character have their value, but for commercial purposes the best test is the practical one of actual use. Until, therefore, the Papuan timbers have been tried in this way, it will be impossible to say what market value they are likely to possess.

The Rand's Record Gold Output.—The output of gold from the Rand in May is the largest on record for that great and prosperous field. The highest previously attained was in March last, when the returns showed 676,065 ozs. valued at £2,742,390. May's returns give 685,951 ozs. at a value of £2,913,734. Of this large yield, the share of the Witwatersrand was 658,196 ozs., valued at £2,795,839, while the outside districts showed a return of 27,755 ozs., valued at £117,895. The total number of stamps employed in the batteries is 9,978, and the tube mills number 218.

Indian Railway Traffic and Trade.—The reports of the fourteen Indian railways, just issued, show an average increase in the earnings of all the railways but two, and the falling off in the returns of the latter appears to be due to local and exceptional circumstances. Two indications, in all the returns, point to a very promising and continuous expansion of trade: the first is, the increase of passenger business, at a time not considered favourable for pilgrimages and other religious duties, which proves that better conditions obtain among the agricultural population, owing to good monsoons; and the other is the fact that freight business has not expanded so generally, on account of a decrease in the movement of food stuffs to districts where a shortage previously prevailed, which is due to the local crops turning out so well that there was no need for the bringing in of grain from the outside. These are certainly very satisfactory indications, in which all who are interested in the progress of our great Dependency will rejoice.

CORRESPONDENCE.

FIRE INSURANCE IN VANCOUVER.

The business section of the city of Vancouver has become so valuable that high buildings are a necessity. They must be sufficiently fireproof to meet the requirements of underwriters in order

that they may be rated at minimum premiums. The business of fire insurance is largely in the hands of American companies; what British and Canadian companies there are have combined with the American companies in adopting uniform rates of premiums.

Materials used and methods of construction in buildings within the municipal limits have to be approved by the Mainland Fire Underwriters' Association, an American institution working in conjunction with the Chicago Fire Test Laboratory. Only such materials or appliances as have been submitted and tested by the Chicago Laboratory and have obtained its label or certificate will be recognised. Should, therefore, any British manufacturers of steel casement sashes, rolling or sliding fireproof doors or shutters, etc., wish to supply their goods, they must submit to the expense of sending their goods to Chicago and pay the fees (which are very high) for inspection, before any business can be done. For American makers this is comparatively easy, but for British manufacturers exceedingly difficult and costly.

I can take the line of least resistance and purchase goods from the States that have the Association's approval, but being still a Briton, and agent for British firms, I naturally prefer to further the interests of my own countrymen, and it does seem anomalous that a part of the British Empire should be dominated by a foreign, though neighbouring, country.

I should be glad to know that some steps can be taken to remedy this injustice.

W. C. THOMSON.

Vancouver, B.C., July 17th, 1911.

GENERAL NOTES.

THE LEATHER DEPARTMENT AT LEEDS.—According to the annual report of the Department of Leather Industries in the University of Leeds, it appears that during the year 1910-11 there were nineteen students in the day classes and twenty-five in the evening classes. A considerable amount of research work is being conducted, and some valuable papers have been published. Three students have taken degrees in Chemistry and the Chemistry of Leather Manufacture, and some changes in the curriculum have been sanctioned by the Senate with a view to meeting the requirements of Honours B.Sc. and M.Sc. students. A former student of the Department has been appointed Leather Trade Expert to the Madras Government, and other industrial appointments have been obtained.

THE TEXTILE INSTITUTE.—The congress of the Institute for this year will be held in Belfast from September 7th-9th. A number of papers will be read, and visits paid to industrial centres.

THE MUSTARD BEETLE.—The Board of Agriculture and Fisheries have received information that the mustard beetle (*Phaedon betulae*) is doing much damage in some districts this season. They desire therefore to direct attention to measures which may be adopted to combat this pest. The beetles hibernate in various shelter places—*e.g.*, in the mustard stubble, in the hollow stems of other plants, in the neighbourhood of the food plants, and in crevices of many kinds. Eggs are laid in spring and summer, and both grubs and beetles feed on the growing plants. Pupation of the grubs takes place in the soil. The beetles may be attacked—(*a*) by dislodging and trapping them by dragging tarred sacking over the young plants when the beetles are observed upon them, and (*b*) by spraying the infested crop with arsenate of lead, which may be obtained ready for use in the paste form, and may be employed at the rate of 4 lbs. of the paste to 100 gallons of water. It has been observed that later in the year the beetles at times migrate in great numbers to other fields, and when this takes place a shallow trench should be dug across the path of the migrating swarm. If the trench is kept tarred many beetles will be caught, notwithstanding the fact that they have wings. After infestation the stubble may be burnt over before ploughing in order to destroy hibernating beetles.

THE INSTITUTION OF MINING AND METALLURGY.—The Council have, on behalf of the Institution, accepted an invitation from the Canadian Mining Institute to hold a joint meeting in Ottawa or Montreal about the first week in March, 1912. It is proposed to arrange a visit to one or two important mining camps after the meeting.

THE MUSEUMS ASSOCIATION.—Count Plunkett, F.S.A., the Director of the National Museum of Science and Art, Dublin, has been unanimously elected President of the Museums Association. The next annual conference of the Association will be held in Dublin, in July, 1912.

THE AUSTRIAN MINERAL-WATER INDUSTRY.—The home product of Austrian mineral springs is divided among the states of the Empire as follows, the figures representing bottles: Bohemia, 27 millions; Styria, 5 millions; Carinthia, 2 millions; Moravia, 1 million; Tyrol, 100,000; Galicia, 66,000; Upper Austria, 31,000; Dalmatia, 20,000; Lower Austria, 15,000; Bukowina, 15,000. The output in bottles of Bohemia's mineral springs is approximately as follows: Giesshübel-Sauerbrunn, 11 millions; Bilin, over 4 millions; Krondorf, over 4 millions; Carlsbad, 3 millions; Teplitz-Schönau, nearly 2 millions; Klösterle, 750,000; Marienbad, 600,000; Neudorf, 430,000; Franzensbad, 294,000; other mineral springs, 209,000. The bulk of the exports of Austrian mineral waters is distributed to Germany, United States, Italy, France, United Kingdom, Russia, and Roumania, the names of the countries being given in the order of their importance as importers.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

ETCHING.

By Frederick Wedmore.

Lecture I.—Delivered January 23rd, 1911.

The Old Masters.

Syllabus.—The Cradle of great Etching—Rembrandt's place—Ostade and Bega—Vandyke—Landscape and Animal Subjects in the Low Countries—The Classic Landscape—Claude—Links with the Moderns—Etching no "Minor Art."

From a printed notice which your Royal Society of Arts periodically issues, I gathered, with momentary forebodings, that your lectures here are expected very often to deal with technical processes. But had that wish been in the present instance your guiding motive you would have invited an etcher, and not a writer, to give the lectures I am now beginning. What etching is, as a craft, is to-day widely understood. No longer, even by the least equipped, is a scratchy little drawing in pen and ink spoken of as an etching. And, for myself, I take leave in this, as in every other Art, to be interested, and to ask the public to be interested, less in the serviceable processes of the craft than in the power of the Art to express with directness such different individualities, such different visions of the world. When the great etcher has gone through his performance—has completed his work—he has given us, not his work alone, but much of his soul. "*Qu'est ce que mon œuvre ?*" asks Maurice Barrès—a master in our craft of writing—and the answer that he gives is this, "*Ma personne toute vive emprisonnée.*"

You will note, from my little synopsis circulated amongst you, that I speak in these lectures almost entirely of two centuries—the seventeenth and the nineteenth. Of all the past, those are the great centuries for the art of the etcher. Your twentieth century is yet so young that it has scarcely shown its general character. In it, nevertheless, have been developed the talents of Cameron, Brangwyn, Muirhead Bone. Next Monday I speak of the etchings that may be called modern. To-day, of the seventeenth century; that is, to put it roughly, of the great Old Masters.

The cradle of fine etching was, of course, the Low Countries. In the seventeenth century, etchers who were great and were not of the Low Countries, were isolated men. Nay, but was there in that century more than one man who was great and neither Dutch nor Fleming? Was there anyone but the author of "Le Bouvier"? Really, outside Holland, with its Rembrandt the immortal, was there anyone but Claude?

First then, for us, the dominating Dutchman, and the inevitable and yet long-settled question, "What was Rembrandt's place?" It was the place of the inspired path-breaker. In the new vista that he opened for those who went upon his road, Rembrandt reminds one of the great initiators in music—takes his place beside them—Bach, it may be, or Berlioz. Rembrandt was an "Old Master"; but some of his work is of such a character that one says to one's self in looking at it, "Yes, but he was also the greatest of the Moderns." "Is it not true that the 'Landscape with the Ruined Tower'—that, more, I think, than any of the others—is the beginning of Modern Art?" The truth is, Rembrandt was a couple of hundred years in advance of his time. In him are the germs of the impressionism of Constable, and of the great French landscapists whom Constable influenced. His progress, technically, followed the course common to nearly every big man's progress—that is, it was a course from precision to breadth; from punctiliousness to that easy mastery that can be economical with learning. That is the course generally. But the *technique* of Rembrandt shows early and surprising advances,

and then, for purposes of the artist's own, a deliberate return, it may be, to the old method. So many themes "indicate"—in the medical phrase—the adoption of so many processes, from the days of Rembrandt's controlled and ordered youth, with his exquisite vision of that *grande dame* among the peasantry—his mother, in his "Head of a Woman lightly etched"—down almost to the days of that so flexible and yielding nudity, "The Woman with the Arrow," with which, substantially, he finished his life-work on the copper.

Another word, it may be, about Rembrandt later; but now I must ask you to transfer your thoughts to two important and unequally known masters of his day and land. One of them is Ostade, and the other Bega; and if I insist a little more upon Bega than upon Ostade it is because Bega has been, upon the whole, so much less considered. Let me make clear, however, that with that high appreciation of Ostade, which is now an accepted tradition, no fault is to be found. Ostade had nearly every quality, except a great soul. Had Bega a great soul? Perhaps not. He had a greater manner than Ostade, in any case. And, likewise, he had less variety. Both men arranged admirably their different materials. Ostade's "The Family" is an unsurpassed masterpiece of composition. Ostade's means of expression, as an etcher, were of extreme complexity--they were of serviceable changefulness.

And now Bega. You are sooner at the end of his resources of method; yet, within their boundaries, how noble his resources are! They are nobler than his themes—but that indeed is the truth about every Dutchman except Rembrandt. Bega's scenes are tavern scenes for the most part. His people pass from gross love to drinking, and from drinking to gross love. But, even in their excesses, how human; their characters how marked! their cordialities how unconcealed! The backgrounds of his pieces, simple, but with what broad and rich effects, what opulence of shadow and light! To possess a sample or so, at the least, of Bega's most individual excellence, becomes for the collector an obligation and a joy.

The art of etching, which could express the assured talent, and the decisiveness of stroke of Bega, could express, happily at the same time, no small measure of the grace of Vandyke, and all of his strength. His grace, moreover, is shown in etching quite independently of that which often prompted it in painting — the elegance, I mean, of courtly womankind. His etchings are a picture gallery of men. Most of them were his brother artists. There is "Vosterman's" for grace; "Vranx" for direct observation; there is the genial "Snellinx"—an etching which Philip Hamerton, rightly enough indeed, called "luminous and lively" — there is, above all perhaps, the portrait of "De Wael." I know you do not put these things—magnificent and authoritative though they are—quite beside the subtle "Clément de Jonghe" and the benign "John Lutma" of Rembrandt; but that is because Vandyke was the Walter Scott, while Rembrandt was the Balzac, of portraiture.

And keeping still Rembrandt as our standard of mastery, we shall not find that the landscape, or the landscape with cattle, of the landscape men of the Low Countries, even of Adrian van de Velde, can be looked upon as altogether on a plane with the landscapes of Rembrandt, at once subtle and overpowering—with that "Landscape with the ruined Tower" I have spoken of already, or the "Landscape with the Obelisk," or the "Cottage and Dutch Hay Barn." No doubt the classic landscape, the more or less classic landscape, of Both, Berghem, and Waterloo, have a course and a charm of their own, making comparison inappropriate. And—but we should first give a word of recognition to the Master of Prague, Wenceslaus Hollar, who worked in England, patronised by the Earl of Arundel, and died here after a life of production laborious and ill-paid—it is the classics that best lead us on to the consideration of Claude. The classics—Both, Berghem, Waterloo—have style, that indescribable quality; they have style, all of them But in style Claude stands above them, because Claude is the very standard of style. It is Claude who sets the pace.

It is unfortunate that of Claude's two dozen or so etchings, very few are apt to be seen by the public in the condition which is necessary, if their pre-eminence is to be appreciated. Etching did not fill a large place in Claude's life. His practice of it was intermittent. Sometimes it was perfect, and sometimes technically imperfect. And, after comparatively few impressions, care was not taken of the coppers. And Claude worked much in isolation, as far as etching was concerned. In his own day his prints were appreciated by but the smallest public. Rarely, I think, can they have had a market. It is to these various causes I assign the present scarcity of the fine ones. Nothing, then, should prevent the collector from laying his hands, where he can, upon those subjects and

upon those impressions which veritably represent this master. The two or three dance subjects—happy peasants in untroubled weather, by quiet waters or under graceful leafage—these things are desirable. So is "The Wooden Bridge." And even more so, in an impression that truly represents the plate, is "The Cattle going Home in Stormy Weather." "In *Showery* Weather," would perhaps better define it. Then there is the popular and famous "Sunset"—No. 15 in Robert Dumesnil's catalogue. And then, above all, I must suppose, towers of right, "Le Bouvier"—a glade, a stream, and the cowherd bringing down the dark cattle. Yes, confessedly, "Le Bouvier"—in a fine impression of it—is the master's unequalled masterpiece.

So much for the seventeenth century. I have said before that little was done in the eighteenth. In England and in Holland, nothing. The slow approach to the true Moderns is to be found, if found at all, in Italy and France; dare I localise it more closely and say, "in Rome, in Venice, in Provence"? Piranesi was at once the recorder of actual Rome, and, in his prison scenes, a dreamer of weird dreams. Tiepolo etched with impulse; sometimes almost with majesty. Canaletto etched with more of continuity and more of calm; never with undue emphasis. I remember Monsieur Béjot pointing out to me that, unlike some more fashionable contemporaries of his own—but Béjot did not put it in that way—Canaletto never made excessive use of black. He did not exaggerate his shadows: no superabundance of mere printer's ink was invited to furnish him with mystery and weirdness, "while you wait."

In France, though people do not know it, the connecting link with modern times was Honoré Fragonard, author of but a few plates, and these neglected even to-day. Child of Provence—where France from remote ages, has most, in aqueduct and tower, in road, in bath, and in arena, betrayed—preserved rather—the closeness of her association, with Rome, and the measure of her debt—what wonder that Fragonard, in his spontaneous fancies on the copper, is himself joyously classic! Nymph and faun occupy his little plates and enliven them. The few pieces have little commercial value; but, I assure you, they are charming.

Back let us go, however, for a moment, just to end—and for a purpose—with those two consecrated names, Rembrandt and Claude, the greatest etcher the world has ever seen, and one of the greatest. These, each in his kind, were men of noble souls, and boundless, tolerant vision; and the art in which they expressed themselves with unsurpassable charm is called, even to-day, by some—rather grotesquely if we think—a "minor art," like enamelling, or lace-making. By minds bound down by convention or limited by thoughtlessness, or want of imaginative grasp, a work of art is apt to be judged by size, by visible ambition, by supposed quality of material. And yet "the coin outlasts Tiberius." Let us receive this lesson, that as men's entrance into the understanding of Art becomes the surer, the less are they inclined to consider one medium as in itself greater, more dignified, than another. More and more are they inclined to value, and to applaud, most of all, the choice of the right medium for the particular theme and the particular temperament. That choice was made, and wisely made, by all the great etchers.

Lecture II.—Delivered January 30th, 1911.

Modern Etching.

Syllabus. — Goya — Wilkie and Geddes — The Silence before the Revival—The great French Outburst—Méryon, Bracquemond and Jacquemart—Haden and Whistler—Themes mainly Landscape, Portraiture, Architecture—The Etching of To-day.

Every young painter who puts forth a claim to be considered, in work and in opinions, up-to-date, feels, just at present, the necessity to be enthusiastic about Goya. Goya was not only gifted—that would not have sufficed at all. Goya was audacious; he was revolutionary. A modified Benvenuto, set in the key of the late eighteenth century, this masterful erratic Spaniard disturbed many comfortable conventions in life as well as in Art. All question of contemporary fashions apart, however—and putting quite into the background the fascination of the man for modern men and women—it seems to me unlikely that Goya's fame, either as a painter or as etcher, should grow less, so fertile was his mind in ideas, so quickly roused his indignation, so prompt and telling his satire, so weird and changeful his fancy, and so certain his hand. Effective in the "Disasters of War," and in the Bull Fight series, it is in the "Caprices" that his art is at its height. Their conceptions are amazing and infinite. Would that the plates, dexterous and brilliant blends of line-etching and aquatint, had been taken better care of, had been more *soignés*, from the first! Then they might have been put into the solander-boxes of the collector, with long accepted master-

pieces. Now, in book-form, each series is nursed for a while upon the knees, with not much more of reverence than the hero of "Fifine at the Fair" would have bestowed, he tells us, on "Doré's last picture book." For all that, Goya is great, and our young artists' and fashionable amateurs' appreciation not in the main erroneous.

In Goya's early days, our Crome—"old" Crome—was doing a few admirable etchings at Norwich—"Mousehold Heath" was the best of them—and in his later, Wilkie and Geddes, in London or in Scotland, were doing respectively "The Receipt" and "Peckham Rye." But, practically, very little of lasting value was done between the time of Rembrandt and the full middle of the nineteenth century, when, not to speak in detail of Bracquemond and Jacquemart—the great etcher of birds and the great etcher of porcelain and *objets d'art*—there burst upon the world—it was in the early fifties—the pregnant and magnetic genius of Méryon. Méryon, in virtue of the dozen or sixteen prints which constitute his more important work—his "Etchings on Paris" (the "on" be it noted, is his own)—is to-day accounted a classic, and, in the print market, hardly a Dürer, hardly a Rembrandt, fetches a higher price than does "L'Abside de Nôtre Dame." This "Abside" —an inspired record of the cathedral church as it is seen from a hundred yards or so east of it, from across the river—is perhaps of all great pieces, certainly of all Méryon's great pieces, the piece most "understanded of the multitude"; but it makes no concessions, it bends to no prejudice; it holds its lofty dignity. None the less, the real collector and the serious student, recognising the height of its beauty, crave to have placed beside it the "St. Etienne du Mont," the "Galérie," the "Morgue," even the "Stryge." Nor does the list stop here, for I said, not four or five, but a "dozen or sixteen." Each slow, deliberate plate of Méryon's, an etching as to its method and medium, an original "engraving" as to its spirit, is a thing not only of immense leisure of execution, but of permanence deserved and undeniable.

The absence of any imagination so exalted and noble as that which Méryon's prints reveal, is to be noticed, but is not to be wondered at, in the work of men who immediately succeeded him. His qualities were of necessity exceptional. If they were shared at all, they were shared by Legros, and then "with a difference." Seymour Haden's qualities, and Whistler's qualities, bear practically no likeness to them. In four years—from the year 1850 to the year 1854—Méryon wrote his "Epic of Paris." Illness—mental illness—had attacked this genius by the time that Haden and Whistler settled to substantial work. That was one or two years only before 1860. Legros—and with the weirdest of his themes—had been a little before them. His earlier art was concerned greatly with ecclesiastical life and legend and with definite portraiture; his later art has had as its theme, more particularly, landscape, good in itself, but which he has refined and ennobled; and I do not know whether to prize the most "Communion dans l'Église St. Médard" and "Les Chantres Espagnols," or, in the later art, "Le Mur du Presbytère," or "Le Pré ensoleillé."

It seems late in the day to speak to you in any detail of Whistler and Haden. Haden's place was the more promptly admitted, and the "Breaking-up of the Agamemnon"—always a *chef d'œuvre*—was an appropriate wedding-present when an etched Nocturne of Whistler's would have been held to be either an enigma to which there was no answer, or a joke of which the point was not discernible. As time went on, the piquancy of much of Whistler's work and his alertness, not to say his aggressiveness, made him noticeable; but he was in his grave before amongst the large public there was any intelligent understanding of his merit. Haden's work was not wanting in originality because it was conservative of tradition; and its conservatism of tradition did no doubt facilitate the promptitude of its appeal. His etchings retained, most of them, the unity of a sketch, but the sketches were classic. I remember he appreciated Whistler very much more than Whistler appreciated him. He told me once—that was many years ago—that were he to part with his Whistlers and his Rembrandts he did not know which of the two would go first.

Whistler's method changed more visibly and frequently than Haden's. We note in it more easily a succession of periods; the Thames period, the Leyland period, the Venetian period, the late Dutch period, to give examples of what I mean. In Haden's work all that we note in this respect is that which I have called before now the customary progress from precision to assured freedom, and in connection with the added breadth, a breadth more sought for, the employment not unfrequently of another metal than copper—the employment of zinc, that gives what is sometimes desirable, "a fat line."

Méryon, Legros, Bracquemond and Jacquemart, Haden and Whistler, prepared the way for the etchings of to-day, in England and France. And the etching of the last few years—the last twenty years—in England has, strange to say, accomplished much more than has been accomplished in France, where coloured etching (practised sometimes exquisitely enough, as by Monsieur T. F. Simon) seems to me on the whole so much less worthy than the etching which, apart from the question of line, concerns itself with gradations of black and of grey up to the white of the paper, and leaves actual colour severely alone. In France, as far as black and white are concerned, we have chiefly to recognise Lepère and Béjot. They are the two masters, and, of both, landscape, and the landscape of cities, is the theme. Béjot, in serene mood, illustrates charmingly the Paris that he loves. The themes of Lepère, in his etchings—not, of course, in his wonderful wood engravings—are country or provincial themes, often. The special character of Paris he seizes less readily than his younger contemporary, Béjot. But in pure sketching you have his "Béguinage, Bruges," and in work carried far, yet never too far, his group of pieces of which the scene is Amiens with its great dominating church.

America, since Whistler, has given us one etcher of high importance, Mr. Maclaughlan, who has his vision of Paris, too, and who has brought home to us all Switzerland, as it were—all the mountains and deep, wide valleys—in his "Lauterbrunnen." Sweden has given us Zorn, who, not to speak of his frequent pre-occupation with the moneyed American, has recorded in a *chef d'œuvre* Renan; in a *chef d'œuvre* Anatole France. Moreover he has seen and rendered the nude—the nude of every day—in a new way in etching. He will last.

But we end with the English—the English who include the Scotch. Strang—a Celt, I must believe—is himself imaginative, though visibly as a follower of Legros. Still, he is far from being only a copyist, an imitator, and he is an extremely capable craftsman. Frank Short, a veritable master of all the craft of engraving except line engraving, has his own vision of the stretched land and the extended waters and the encompassing sky. Haig, Hedley Fitton, Alfred East, Burridge, Goff, Watson, Sickert, Sparks, Luke Taylor, Watson, Mulready, Stone and Martin Hardie, Affleck with his "Toledo" like a "cry in the desert," and half-a-dozen others, were there but time, claim quite substantial comment. Roussel, of French birth but English residence, must certainly be named, in virtue of plates which, a thousand times less than some people suppose, repeat Whistler—they scarcely repeat him at all, but in the accident of their themes at Chelsea—and Roussel is the author of "A French Girl" and other dry points of the face and figure, of singular distinction, of high and lasting charm. Then, very notable, and now widely accepted, are Brangwyn, D. Y. Cameron, and Muirhead Bone. Bone is an instance of the truth of Dr. Johnson's saying, "much may be made of a Scotchman if you catch him young." Bone's dry points of London, the best of them, such as "Clare Market," "St. John's Wood," would make of him a little classic, but so would "Ayr Prison"; so, too, would "Leeds Warehouses." And sometimes scaffolding, in its complexities of line, suffices for him—scaffolding or the squalid suburb. Cameron asks generally for subjects more obviously noble, and, out of a masterpiece in one Art makes a masterpiece in another; he adds a glamour of his own to the "Saint Gervais," to the "St. Laumer," to "The Five Sisters of York." Brangwyn's plates are huge plates—too many of them, and according to Whistler "the huge plate" is an offence, but their hugeness does not destroy, although it may impair, their merit, or perhaps their fascination. Brangwyn's plates have their valuable individuality, their strength of draughtsmanship, their deliberate preoccupation with noble design. And to be preoccupied with noble design is, of very modern "notes," one of the healthiest and best.

CHINA AND OPIUM.

It would be difficult to point to any act of national renunciation quite like that of China in stamping out the use of opium. At the beginning of the present century the opium used annually in China equalled 22,588 tons, of which about one-seventh came from India. The Chinese Government has always been opposed to its use, but until it was able to regulate the import of foreign opium its efforts at suppression were perfunctory and ineffective. In 1909 the Powers interested met in conference, and resolved that it was the duty of the respective Governments to prevent the export of opium to any countries prohibiting its importation. Concurrently, the Chinese Government determined to compel the cessation of production and consumption of opium in China within a given number of years, and the British Government agreed to reduce the export of Indian opium by one-tenth of the amount annually taken by China, so that the export of Indian opium to China would cease in ten years. The result is given in the

remarkable despatches from Sir A. Hosie, which have just been issued (China No. 1, 1911). Sir Alexander Hosie has made personal journeys into some of the opium-growing districts, and has received reports from consuls and non-official persons resident in or acquainted with other districts; and, although he does not endorse some of the more glowing statements as to the complete suppression of poppy cultivation, and evidently commenced his inquiries in a sceptical spirit, his admissions are significant, whilst the statements of other competent witnesses are very remarkable. Take Shansi. "Not only," writes the Consul-General, "did the governor and provincial assembly assure me of absolute suppression, but all British subjects with whom I came in contact informed me that, to the best of their knowledge and belief, opium was no longer a product of Shansi, and the fact that his Excellency invited personal inspection of his province by a British official would appear to show that he was perfectly convinced that eradication was complete." Sir Alexander himself says: "There is reason to believe that the poppy has ceased to be cultivated in the province for the last two years." In Shansi, large opium establishments numbered fifty-six, with a capital of about 900,000 taels, while raw and prepared opium shops were scattered all over the province. These were all closed in the beginning of 1910, so that there is not now a single opium establishment or shop. Nor is this all. Not content with suppressing the cultivation of the poppy, the Government has sought to cure the opium-smoker of his craving. To quote Sir Alexander Hosie: "There are ten official refuges in different parts of the province through which over 100,000 smokers have passed and been cured, and this number is exclusive of persons treated in over 400 unofficial refuges. His Excellency estimates that from 50 to 60 per cent. of smokers in the province have been completely cured, and there still remain the old and the infirm, who are being advised to give up the habit, and will in the end be successfully dealt with."

When the Consul-General was in Hsi-ai-Fu he asked the Rev. A. G. Shorrock, of the English Baptist Society, who has spent many years in Shansi, and who was at the time of his visit collecting information regarding opium from all parts of the province, if he would send him a few notes on the subject, as soon as his information was complete. Mr. Shorrock did so. In these notes he writes: "The price of opium, as compared with former years, indicates, more than anything else, the rate of production now. More than four times the price is now charged, as compared with previous years." And Mr. Shorrock makes the following piquant observations: "Such a change is only possible when supported by popular sentiment. No other change appeals as this has done to the conscience of the people. I have seen the farmers take their implements to the mandarin and refuse to work when a comparatively small tax has been levied; but, although the people have incurred great loss by the suppression of opium growing, no such risings have yet taken place, at least to any extent."

Szechuan was for many years the greatest opium-producing province in China. The Consul-General estimated, when he was officially connected with the province in 1909, that the production exceeded 200,000 piculs, or about four times the annual importation of Indian opium into China. In 1908 the prohibition was imposed, with the result that in his despatch to Sir E. Grey of April 10th, 1911, Sir Alexander Hosie is able to write, "In not one of these districts did I observe the poppy, and the result of my investigations was fully corroborated by the testimony of missionaries whom I took the opportunity of questioning whenever possible. They had neither seen the poppy nor heard of its cultivation during the season of 1910–11. . . . I am satisfied that poppy cultivation has for the present been suppressed in Szechuan."

Yunnan has always ranked next to Szechuan as the second greatest opium-producing province in China, and the quality of its opium has always held the first place in the estimation of consumers of the native drug throughout the Empire. The total annual production of the province prior to the introduction of the measures for the suppression of cultivation and consumption taken in obedience to the Imperial decree of September 20th, 1906, has been variously estimated at from 30,000 to 78,000 piculs: probably 60,000 piculs would be a nearer approximation to the actual production. Sir Alexander writes: "Writing of this place—the greatest opium-producing centre in eastern Yunnan—which I visited in June, 1882, I said that judging from the number of withered poppy-stems to be seen among the summer crops of maize and beans, it must have been one field of poppy, and such it continued to be annually until the measures of suppression were introduced. From the time I entered Yunnan I heard that the poppy had not been cultivated for three years, and, as regards the Chao-t'ung plain, this was fully confirmed by the English Methodist Mission, one of whom has been resident in this and the neighbouring prefecture of Tung Ch'uan Fu for over twenty years. Not only had no opium been cultivated on the plain for three seasons, but, so far as they could ascertain, there was no cultivation of the poppy within the whole of the prefecture."

These despatches of Sir Alexander Hosie present a wonderful picture of the government of a great nation bent on the eradication of a national vice, and, aided by the willing acquiescence of the people, sweeping it from vast provinces.

THE TEXTILE FIBRE INDUSTRY OF BRAZIL.

With the world's source of cotton supply in the main limited to the United States, and in view of the reputed failures to develop the cotton-growing industry in India and Africa on a very large scale,

it would seem that Brazil will, within the next generation, witness an extension of its cotton industry, and when such a time comes its cotton-bearing trees will have their share of attention in this respect. There are indigenous to Brazil, and growing wild in certain regions, two well-known species of trees which are of interest to the commercial world because of their possibilities as producers of cotton fibre. Not the least remarkable feature about these trees is their occurrence in precisely those regions where it has seemed to be impossible, or at least difficult, to grow ordinary cotton. No other country in the world possesses so large an area of land which may be utilised for the growing of cotton as does Brazil, and that in other areas it is possible to cultivate trees for the production of cotton fibres must appeal to the textile-producing world as indicating that Brazil must be reckoned with as a future source of the world's cotton supply. The United States Consul at Rio de Janeiro says that one of these trees is called "Barraguda," from its being barrel-shaped, after the peculiar trunk which is its characteristic. The tree grows from twenty-five to thirty-five feet in height, tapering from the great bulge in the trunk to a very slender one, from which branches form about twelve feet above the ground. The trunk is entirely covered with hard and sharp thorns. The pods in which the cotton grows are from five to eight inches long, and two to four inches in diameter. The fibre is coarse and white, and adheres closely to the seeds, which are somewhat smaller than peas. It is a long and strong fibre, and while too coarse for use in textiles of any degree of fineness, it would, it is said, lend itself to the fabrication of blankets, cotton twine, and a variety of other materials. The habitat of this tree is in central and southern Bahia, and it grows to a lesser extent in the State of Pernambuco. The uplands on which it seems to flourish are from a thousand to sixteen hundred feet above sea-level, where there is a decided chill in the air during certain months of the year. The other tree produces a much finer cotton, of a brownish colour, exceedingly light, but not long enough to spin well, and resembles eider-down. The pods in which it grows are about ten inches long and one inch and a half in diameter before bursting. When the pod bursts and the ripe cotton comes out, the pod takes on a rotund shape eight to ten inches in diameter. The fibre adheres loosely to the seeds, most of which fall out by merely shaking the pod, and is so light and fluffy that one can blow almost the entire contents of a pod free from the outer enclosure or hull. Occasionally this cotton is used in pillows, and when properly prepared is said to be as soft and downy as the lightest and best feathers, showing no tendency to harden with use. The inner bark of this cotton tree is utilised by the inhabitants for many purposes. It is a remarkably strong fibre, and a strip half an inch in width will, without any preparation, sustain a weight of fifty to a hundred pounds. The tree has its habitat in central Bahia and northern Minas Geraes, being most abundant in the latter State, and is called "imbirussu," being a name of Indian origin, probably given to it because of its peculiar and characteristic bark. The corrugations of the bark form diamond-shaped patches, the inner parts of which have a bright, greenish-red and glossy surface. Both of these trees are hardy and long-lived, seventy-five to one hundred years being apparently a fair average for the period during which they bear cotton fibre, while the common cotton-plant bears in many parts of Brazil for fifteen to twenty-five years without any attention whatever.

ACCIDENTS IN MINES AND QUARRIES.

Part I. of the general report of the Chief Inspector of Mines, dealing with District Statistics of Mines and Quarries for 1910, has just been issued as a Blue Book [Cd. 5794]. The total number of persons employed in and about the mines of the United Kingdom was 1,078,083, of whom 1,049,407 worked at the 3,253 mines under the Coal Mines Act and 28,676 at the 663 mines under the Metalliferous Mines Act. In coal mines there was an increase of 35,409 persons over 1909. Of the total 848,381 were employed underground. Of 1,201,026 surface workers, 6,221 were females. The total number of workers under sixteen, surface and underground, was 72,094. At the quarries, 85,837 persons were employed. The output of coal in tons was 264,417,588, an increase over 1909 of 658,716. The output of minerals under the Metalliferous Mines Act was 3,241,453 tons, of which 1,851,351 was iron ore. Stone and mineral under the Quarries Act amounted to 46,138,751 tons, of which 4,987,613 were iron ore. The total iron ore produced from all sources was 15,226,015 tons.

With regard to accidents, there were at the mines under the Coal Mines Act 1,242 separate fatal accidents, causing 1,775 deaths. Compared with 1909, this is an increase of 60 accidents and 322 deaths. Of those killed, 114 were under sixteen, as against 95 in 1909. At mines under the Metalliferous Mines Act there were 38 fatal accidents and 43 deaths, the accidents being the same as the previous year and the deaths showing an increase of three. There were 80 fatal accidents in quarries, with 84 deaths, three fewer accidents than in 1909, but the same number of deaths.

Non-fatal accidents in coal mines causing disablement for more than seven days numbered 158,565, the persons injured numbering 159,042. At metalliferous mines, 1,578 accidents occurred, injuring 1,596 persons; at quarries, 5,156 accidents, injuring 5,175 persons. These figures show an increase over 1909 of persons injured—namely, 5,736 in coal mines, 162 in metalliferous mines, and 319 in quarries. The non-fatal accidents reported to inspectors were: In coal mines, 5,432 (a decrease of 43); in metalliferous mines, 281 (an increase of 18); in quarries, 1,385 (a decrease of 20).

In coal mines the death-rate was, of underground workers, 1·91 per 1,000 persons employed, as

against 1·61 in 1909; of surface workers, ·76 per 1,000, as against ·67 in the previous year; the death-rate of the whole was 1·69, as against 1·43 in 1909. Of persons under sixteen years, the death-rate was: Underground workers, 1·77; surface workers, 1·03; for both together, 1·58. Corresponding figures in 1909 were 1·49, ·62, and 1·26 respectively. In metalliferous mines the death-rate was 1·50 per 1,000 (1·41 in 1909)—underground workers, 2·16 (1·97 in 1909); surface workers, ·52 (·60 in 1909). In quarries the death-rate was ·98, as against 1·00 in 1909; for inside workers, 1·38 (the same as in 1909); and for outside workers, ·29 (as against ·36 in 1909).

The total number of deaths (1,775) from accidents in coal mines is the highest yet recorded in any one year; those from explosions have only been exceeded twice—in 1866 (651 deaths) and 1878 (586 deaths). The number of deaths from falls of ground is also the highest recorded, namely, 636. The report states that one must go back to 1890 to find a higher death-rate from all causes underground, namely, 2·09 per 1,000. That year, like the one under review, was marked by serious colliery explosions.

AN AEROPLANE POST.

The *Times* announces that an experiment in the direction of utilising aeroplanes in the postal service of the country is likely to be undertaken shortly by the General Post Office. The proposal is for a regular aerial service for a limited period between London and Windsor. Many details have still to be settled, and negotiations are now proceeding with a well-known airman for the supply of suitable machines.

The scheme is stated to owe its inception to the enterprise of a few gentlemen in London interested in aviation, their objects being to further the science of aviation in this country, to demonstrate the utility of the aeroplane, and to benefit certain charities. The last-named object was to be achieved by issuing special postcards and envelopes for the aerial service at 6*d*. and 1*s*. each respectively. All takings in excess of working expenses would then be divided among the selected institutions.

The Postmaster-General was approached on the subject, and not only gave his consent, but readily agreed to co-operate. The aerodomes at Hendon and Windsor Park were selected as the points to be connected by the service. Arrangements have been made with a number of large firms for the fixing in their establishments of special "aerial" letter-boxes, in which letters intended for the aerial service must be posted. Daily clearances will be made by postmen, and the collections will be despatched to the central clearing house. Here the letters will be placed in sealed bags and conveyed by motor-van to Hendon. At the aerodome they will pass from the direct control of the postal officials into the hands of the aeroplane staff. The bags will be securely fixed to the machines, and the airmen will then start on the journey to Windsor, covering the distance of twenty-one miles in, it is estimated, half an hour.

THE TRADE OF MARSEILLES.

The last Consular report on Marseilles contains some interesting information respecting the progress and trade of the port. The great public works in progress, or planned, the advance in technical education, the solution of sanitary and social problems, sound municipal finance, aided by a readjustment of local taxation, may soon be expected to bring about a noteworthy improvement in local conditions. The vast sanitary works, completed in 1897, since when public health has so greatly improved, soon to be followed by the purification of the Marseilles water-supply, now under discussion by the municipality after exhaustive tests, will have transformed the sanitary conditions of the town. The civil hospital is being rebuilt on modern lines, and the construction of a new hospital for contagious diseases is planned. Large public parks are being added to the existing ones for the recreation of the people and the health of its children. Sporting clubs, walking clubs, football clubs, amusement parks (started with British capital), are adding in a marked measure to the open-air life and the general improvement of the people. Wages earned are higher, but foodstuffs have, unfortunately, with the exception of bread, risen in price, and the two last severe springs have ruined the fruit crops, upon which the population so greatly depends. The spending power of Marseilles has increased, and there is a demand for a better class of articles and a greater variety as well. The brick and roofing and flooring tiles industry has taken a large development. Marseilles exports roofing tiles principally to Algeria, Turkey, Russia and Australia, and bricks mainly to Senegal, and flooring tiles principally to the Argentine Republic. Considerable capital is being invested in glass works, with satisfactory results. The paper works in the neighbourhood turn out about 900,000 tons of paper and cardboard per annum. The industrial activity of Marseilles has been shown in providing electricity and cheaper gas; in its mineral oil-refining works; the bauxite and aluminium industry; in sulphur-refining; in the production of soap, candles, glycerine, oils, tiles and chemicals; in sugar-refining and flour-milling; in the manufacture of macaroni and semolina; in its great trade with the colonies, importing their raw materials and exporting the manufactured products. The principal centres of industrial and agricultural activity of the district are the coal-mines of Grand Combe and Graissesac. Of the total quantity of coal of all descriptions (1,339,200 tons) imported by sea into Marseilles during 1910, 1,066,203 tons came from the

United Kingdom, the remainder from Germany (186,000 tons) and America (87,000 tons). The total importations of coal for 1910 show a slight decrease on the figures for 1909 (1,441,826 tons), the decrease being mainly attributable to the fact that many of the local factories which formerly used coal for raising steam-power now employ electric-power. The bauxite industry has made great strides during 1910. Total shipments from Marseilles amounted to 67,752 tons, as compared with 52,362 tons during 1909; shipments to the United Kingdom were 19,233 tons, as compared with 1,959 tons during 1909, a large increase. The shipments of bauxite show an increase of 50 per cent. at St. Raphael, in the Var, where 36,396 tons were shipped to Scotland and Germany during 1910; a slight decrease at Toulon, in the Var, 44,600 tons for 1910, and a decrease of 25 per cent. on the small export at Cette of bauxite from the Hérault, about 10,000 tons during 1910. The Franco-American competition for the supply of the French market at Marseilles in sulphur has become very brisk. The imports of coarse sulphur rose to 58,567 tons in 1910 from 44,274 tons during 1909; refined sulphur from 110 to 627 tons. The prices ruling at the beginning of 1911 have not varied. For pure sublimed sulphur vine-growers are now paying 7*s*. per cwt. Marseilles imported during 1910, 592 tons of wools in bulk, and in skins from the United Kingdom, 265 tons less than in 1909; 7,789 tons from Australia and New Zealand (an increase of 682 tons); 221 tons from India (a decrease of 216 tons). The statistics show that the general importation of wools during 1910 was 22,000 bales less than that of the preceding year, of which 4,000 bales were for spot sale and 18,000 bales in transit. This falling off is not so serious as it looks, as the imports of 1910 are well above the average of the importations of the last ten years. The average prices were slightly higher than those of 1909, and there were only small fluctuations. This firmness of rates and the prompt realisation of the wool has been very favourable to importers, and the year 1910 must be considered as having been satisfactory to all in the wool business. It has been able to show the vitality of the Marseilles market and the importance, often misunderstood, of the local wool-washing industry. Although the financial crisis in America may have prevented orders from that country, and although the Marseilles stock has rarely given to users the opportunity of getting their full supply, Marseilles washers alone have been able to absorb, at prices surpassing those of their opponents, the greater part of the wools imported to this market. An interesting development has within ten years taken place in southern French shipbuilding. The shipbuilding yards of the Chantiers de Provence, at Port-de-Bouc, at the mouth of the Etang de Berre, where at first only dredgers, lighters, and small steamers were turned out, now employ 1,100 men, and have launched vessels of nearly 12,000 tons displacement. Of the total imports, which reach 5,096,628 tons, the British flag comes in for 1,270,767 tons and the French for 1,786,063 tons. The export movement has been less remarkable; the increase only reaches 61,488 tons, an increase of 84,207 tons under foreign flags and a decrease of 22,769 tons under the French flag. The exports under the German flag have increased by 25,645 tons, and the British decreased by 14,099 tons. On the other hand, as to passengers, 1,504 more than in 1909 have been carried under the British flag, and 104 less under the German. The tables indicate a falling-off of 382 ships, but an increase of 632,892 registered tonnage, showing the tendency to increased tonnage of ships. On this quantity the French flag shows an increase of 52,727 tons, and the foreign of 376,916 tons. Shipping under the French flag absorbs 25·33 per cent.; other shipping, 74·67 per cent. of the total tonnage of the port of Marseilles. In spite of competition the port of Marseilles holds its own.

HOME INDUSTRIES.

The Shipping Industry.—Notwithstanding the lock-out of shipyard workers and the closing down of all the federated shipyards at the close of last year, and the series of strikes of seamen and dock and harbour labourers still unsettled, the outlook for British shipping from an economic point of view is more favourable than it has been for many years. The world's trade offers at the moment active and profitable employment to merchant shipping. This trade has been growing, and is still growing, in spite of many restraining influences, and if the world's harvests this year realise present estimates and expectations there will be a still larger movement of international commerce, and consequently a still larger demand for sea-carriers. The cessation of the shipping boom of 1907 has permitted shipping to come more into relation with commercial requirements. During the last three or four years shipbuilding has been so reduced that commerce has had time to grow up to it. There is still an over-supply of certain kinds of ships in certain trades, but much of the surplus tonnage of four or five years ago has been utilised in various ways, and the supply of floating shipping has not been increased within the past twelve months in proportion to the increase of trade. This readjustment of proportions is partly the result of the slowing down of building during the dull years, and partly of delays in building caused by the shipyard lock-out last year, and the amount of traffic to be sea-borne has grown more rapidly than the available tonnage. Further rise in the freight markets may be looked for in the autumn, though that does not necessarily mean that all shipowners are making more money, for working costs have risen and are rising under the demands for increased wages, irrespective of freights. It may be hoped that the present brighter prospect for shipping will not encourage a renewal of the building of steamers on long credit for impecunious owners, who get up small companies and run vessels on credit, regardless of profit, for the sake of the commission they draw on gross earnings.

The Telephone Industry.—On July 27th the National Telephone Company held its forty-eighth ordinary general meeting, which was its last. At the end of the year, as all know, the whole of the telephone system of this country will be operated by the Post Office as a Government institution. We are often taunted, as a country, with our backwardness in the use of the telephone, and there is some ground for the taunt; but, notwithstanding, the National Telephone Company, which has had many difficulties to reckon with, is able to show a fine record of progress. Thus, for the six months to June 30th, 1894, its income was £327,000; for the six months to June 30th, 1911, it was £1,634,447. After deduction of working expenses the balance in 1894 was £140,500; for the past six months it was £576,278. The amount to be put aside for reserve for the six months ended June is about two-thirds of the total net income for the half year to June 30th, 1894. And notwithstanding the approaching transfer, the business continues to grow. During the past half-year 15,675 stations were added to the system as compared with 16,286 stations in the corresponding period of 1910. The income secured in respect of the business of the half year shows an increase of £129,559, as compared with the corresponding half of 1910. The business has increased by practically five times in seventeen years, and the income accrued in respect of this business rose from £738,680 in 1894 to £3,422,423 in 1910. The net earnings for 1894 were £279,176; for 1910, £1,105,572. In 1904 the Company carried to reserve £58,429; in 1910, £375,000. The rentals carried forward for unexpired terms were only £313,979 in 1894; in 1910 they were £1,413,376. At the meeting of July 27th the Chairman was able to say that, in his opinion, the reserve fund has now reached a sum which should be ample to protect the shareholders' capital from any possible diminution in value.

The Cotton Crop.—The American cotton crop conditions appear favourable. Reporting upon the Troy district, Alabama, Messrs. Bashinsky & Co. write, under date July 15th:—"Weather conditions over the greater portion of this section have been perfect during the first half of this month. Showers have been abundant, though not evenly distributed. In many places where rain is still needed, the plant shows some discoloration, but indications point to a continuation of showery weather, and the dry places will, in all likelihood, receive their share of moisture in due time. Fields present a tangle of spreading foliage, and on examination of the stalk a good supply of bolls, ranging in size from half to full grown, is revealed. The season thus far has been conspicuous by the absence of rust or shedding, and if growth is not checked by an early change to prolonged dry weather, good results from the top crop may be expected. But it must be borne in mind that there is but little 'made' cotton as yet. In the present critical stage the plant cannot stand a protracted drought, and any damage from that source would prove irreparable. The Government agent, after a recent inspection of the five infected counties of this State, reports the appearance of the boll weevil less than expected, owing to the pretty thorough destruction of the cotton stalks and cleaning of the fields last fall. He does not think they will suffer more than 5 per cent. damage." The reports from Egypt warrant the hope that the cotton crop in that country will not be below a good average.

Labour Disputes Settlement.—Reference was made in these Notes recently to Sir C. Macara's proposals for the settlement of labour disputes. He explains that he does not suggest interference with the work of any conciliation body that has already been established, but rather the filling in of a gap that exists in the means of bringing together disputants on either side. Referring to Sir S. B. Boulton's description of the origination and proceedings of the London Labour Conciliation and Arbitration Board, and the Chamber of Commerce, Sir C. Macara writes:—"With the fullest acknowledgment of the splendid work undertaken by the chambers of commerce throughout the country, it is undeniable that the great organisations of employers and workmen would never agree to submit their cause, when deadlocks arise in our staple industries, to such a body as Sir S. B. Boulton suggests. The scheme I have proposed suggests the creation of a special department, with a chairman, deputy chairman, and staff, assisted by an advisory body composed of men who have occupied leading positions, on the side of both capital and labour, in the great staple industries upon which our national existence depends, and this tribunal would be requisitioned only when deadlocks arise in the negotiations between disputants in these industries. The proposed new official staff would also deal with disputes in the smaller industries, in places in which no such admirable organisation exists as that of which Sir S. B. Boulton has been so long the chairman. The capacity of the Board of Trade for dealing with the calls upon it, at a time of great industrial unrest such as that through which we are now passing, must be strained to the utmost; and in my opinion an entirely new department is a necessity of the times."

Employers' Liability Insurance.—It has long been known that insurance companies doing this kind of insurance business are greatly dissatisfied with the results, and some of them are considering whether it would not be possible to rate the risks on a more scientific system than that now in operation. In fire insurance, where the tariffs apply to many manufacturing processes, account is taken of the hazardous features existing in premises where the work is carried on, and allowance made for appliances which minimise the risk. In fact, the tariffs embody an attempt to assess each individual risk on its merits. But in employers'

liability insurance a cruder system prevails. The companies do not make a general practice of inspecting the premises where the work is carried on, and few or no questions are asked with regard to hazardous features or conditions in individual premises, or the precautions taken against accidents. It would not be possible to apply the practice of fire insurance companies in its entirety, but it is pretty safe to say that sooner or later the present methods of employers' liability insurance will be modified.

Sulphate of Ammonia and Nitrate of Soda.—The producers of sulphate of ammonia are periodically disturbed by the fear that the demand for nitrate of soda may seriously affect their business, but it would seem that there is plenty of demand for both commodities. The demand for nitrate continues to increase, and during the past twelve months shipments have largely increased—during the last year they have amounted, roughly, to 200,000 tons—but prices continue to tend upwards. Producers are now getting quite sixpence per quintal more than they were willing to accept only a few weeks ago, and at 7*s.* 6*d.* for refined nitrate the better situated producers can earn very substantial profits. The considerable advance in prices which has taken place is also calculated to stimulate the output, but will not, it is thought, more than meet the growing demand. Notwithstanding the steadily increasing shipments, the European stocks show a decline of nearly 50,000 tons as compared with the corresponding date of last year, and a further moderate rise in prices is not at all unlikely.

Linoleum.—The conference at Berlin, held under the auspices of the German Linoleum Syndicate, has led to an agreement which has for its object the maintenance of prices on a stable basis. When the Syndicate was formed at the beginning of the present year, minimum prices were fixed in accordance with the increase of approximately 30 per cent. in the cost of manufacturing linoleum, mainly due to the advance in the price of linseed oil. It is not now intended materially to alter these prices, but the German producers wish to make the agreement between the German and British producers for the delimitation of the territories of the respective groups more rigid. The British makers, however, are indisposed to changes which might, as they think, alarm customers.

NOTES ON BOOKS.

THE VENTILATION OF ELECTRICAL MACHINERY. By W. H. F. Murdoch, B.Sc., M.I.E.E. London: Whittaker & Co. 3*s.* net.

It appears that the amount of literature on the ventilation of machinery is quite out of proportion to the importance of the subject. To a certain extent the efficiency of machinery depends upon the possibility of ventilating it, for one of the reasons for the present high cost of electric generators is the fact that only small rises of temperature are permissible, and Mr. Murdoch thinks there is little reason to doubt that "with the advance of technical applications and artificial local cooling the cost of large generators may be reduced to one-half or one-third of the present cost per kilowatt." In this volume he discusses the effect of increasing the output above the normal on the efficiency of a generator; natural cooling; heating and cooling curves; the ventilating action of an armature and fans; the refrigerator as a cooling agent; practical methods of ventilating motors, etc., and he concludes with a section on data for thermal calculations. The book is a useful contribution to a subject which has not yet received the attention it deserves.

A HISTORY OF ARCHITECTURE IN LONDON. By Walter H. Godfrey. London: B. T. Batsford. 7*s.* 6*d.* net.

Everybody knows that London contains a very large number of beautiful and historical buildings, but it requires an unusually extensive and peculiar knowledge of London to say where most of them are, or to mention their principal characteristics, historical or architectural. The object of this book, as stated by Dr. Philip Norman in a brief introduction, is "to provide the means for the easy discovery of these buildings, and at the same time to give their historical interpretation."

Of course, no attempt has here been made to write a complete history of the architecture of London—that would be out of the question within the limits of such a volume—but a considerable number of buildings have been selected, and in such a manner as to give the various periods their proper relative treatment. Naturally enough, the majority of the buildings described are well known, but to most readers of the book there will be a few pleasant surprises. A useful feature of the volume is a series of maps showing the sites of many of the most interesting buildings, and a list of the buildings contains a few essential particulars as to their chief characteristics and how and when they may be seen. The illustrations, of which there are 250, deserve careful study; among them it is pleasant to recognise several of Crosby Hall, now satisfactorily settled in its new home at Chelsea.

GENERAL NOTES.

THE INSTITUTE OF METALS.—The annual autumn meeting of the Institute of Metals will be held at Newcastle-on-Tyne on September 20th, 21st, and 22nd. The Hon. Sir Charles A. Parsons, K.C.B., F.R.S., LL.D., is acting as chairman of the local committee, and Dr. J. T. Dunn, F.I.C., as honorary secretary. The meeting will open at 10 a.m. on Wednesday, September 20th, when the members will be welcomed at Armstrong College by the Right Hon. the Lord Mayor of the city, Sir

W. H. Stephenson, D.L., D.C.L., and the local committee, after which a series of papers will be read and discussed, Sir Gerard A. Muntz, Bart., President, being in the chair. In the afternoon members will have the opportunity of visiting shipbuilding, engineering, metallurgical, and electrical works in the neighbourhood. On Thursday, September 21st, papers will be read and discussed at a morning session of the Institute, and in the afternoon there will be further visits to works. For September 22nd the Tyne Improvement Commissioners have placed a steamer at the disposal of the local committee for a voyage to the mouth of the river and back.

THE BIRTH-RATE IN FRANCE.—The *Journal Officiel* states that the number of births in France in 1910 was 774,358, as compared with 769,969 in 1909, showing an increase of 4,389 in favour of the former year. The deaths, however, were fewer last year than those of the previous one; being 703,777 in 1910 as compared with 756,545 in 1909. In 1910 the number of births exceeded those of deaths by 70,580, as compared with 13,424 of the previous year. This great disparity is due to the fewer number of deaths last year as compared with that of the previous one.

THE OIL WELLS OF BURMA.—The most productive oil-fields in Burma are on the eastern side of Arakan Yoma, in the Irawadi Valley, in which is the well-known Yenangyaung field, with an average daily output estimated at 56,000 gallons. Oil is known to exist further south and north, but those areas have not been thoroughly prospected. Nine companies, with a nominal capital of about £12,000,000, are actively engaged either in the extraction of petroleum or in the allied industries —such as refining, etc.—and, according to the American Consul at Calcutta, over £4,000,000 have already been invested in the enterprise. This is apart from the number of small native concerns engaged in working petroleum in their hereditary oil reserves. Burma exported 784,852 gallons of kerosene oil during the year ended March 31st, 1910, and 3,852,160 gallons of fuel oil, while her coastwise exports to India proper amounted to 84,280,000 gallons.

THE NETHERLANDS MARGARINE INDUSTRY.—The Netherlands is among the leading European countries producing dairy articles, on account of its excellent natural butter; but its margarine, or artificial butter, is also one of the principal industries of Europe, and was of importance before any other country had begun to manufacture it. In 1871, two years after Mège-Mouries had made his discovery, a Dutch firm bought his secret and established at Oss, in Brabant, the first manufactory of artificial butter in the world. When the secret shortly after became known to the public, a large number of margarine manufactories came into existence all over the Netherlands, principally in places where many cattle were found, so that a large quantity of milk could easily be bought. There are in the Netherlands a score of margarine manufactories, employing about 1,900 workpeople. Of these, five are in Rotterdam, employing 900 men. Dutch enterprise also controls large margarine manufactories in foreign countries, among other places at Antwerp, Brussels, Hamburg, and Cleves. The Dutch law prevents as much as possible margarine being sold under the name of natural butter. The development of the Dutch margarine industry has created an important trade, not only in the product itself, but in all the materials necessary for its production. The trade in raw margarine and neutral lard is concentrated at Rotterdam, as the majority of the margarine manufactories are situated in the southern part of the country.

THE TURKISH WOOL INDUSTRY.—The provinces of Adana and Angora, in Asiatic Turkey, are known for their fine breed of sheep, which annually yield large quantities of excellent wool suitable for the manufacture of carpets. The Adana wool is coarser than that of Angora, which is very fine. The former is preferred in the American market, because it is much longer. Thus, of the 250 tons of wool produced in the Province of Adana in 1910, about 160 tons were exported to the United States, 40 tons to France, and the balance for use in Turkey. The entire yield of wool of the province of Angora is over 1,000 tons per annum, most of which goes over the Anatolian and Bagdad Railway to Constantinople, and is thence exported. About 150 tons, however, are brought by camel to Mersina and shipped to Germany, France, and Austria. With the completion of the new sections of the Bagdad Railway, now under construction, a much larger part will come to Mersina, which will then become an important wool market.

CULTIVATION OF FLOWERS ON FRENCH RIVIERA.—The exports of flowers from the French Riviera has of late years assumed proportions not contemplated even ten years ago. The value of the cut flowers sent away annually from the "Côte d'Azur" may be roughly estimated at fifty millions of francs (two millions sterling). Amongst the principal flowers grown for export in this region, which comprises Grasse, Nice, and Cannes, the carnation takes a prominent place. Of late years a demand has arisen for a strong, rigid, stalked variety, *à tiges de fer*, in place of the old-fashioned kinds with more pliant stems formerly grown. This condition has been met by the introduction of American varieties of the plant. It has been found by careful analysis that the flower stems of these new varieties contain not only a larger percentage of dry substances—nitrogen, phosphoric acid, and potash—than those with less rigid stems, but that they absorb a greater amount of nourishment from the soil. These facts should not be lost sight of in the cultivation of the flower, and in the use of suitable manures.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

INDIAN SUPERSTITIONS.

By M. N. Kurup.

[Sir George Birdwood, by whom the following article was seen through the press, writes on it:—

"Mr. Kurup's paper is well worthy of a place in the *Journal*, and is most valuable as an appendix to the excellent paper on the same subject recently read before the Society* by Mr. R. A. Leslie Moore. The lizard referred to is the omnipresent 'house lizard,' or 'wall lizard,' of the East Indies, as distinguished from the 'garden lizard' of Anglo-Indians; its widest spread native Indian name, in nearly all Indian languages, being *chipki*, with its variants *chipka* and *chipkali;* obviously an imitation of the sudden, sharp, and [seeming] significant cry of this wee saurian; because of which, and its supernatural voracity [for if in appetite it will incontinently turn and devour its own flesh !], and its unavoidable ubiquity, it has been immemorially accepted throughout India, and Farther India, and the Indian Archipelago, as the universal village oracle, and most powerful ally of the *jotishi*, or village astrologer; a special *Shastra*, or Sacred 'Book of Instruction,' the *Gauli Shastra*, quoted by Mr. Kurup, being devoted to the interpretation of its cries, and the actions, accidents, and other incidents of its intrusive and impertinent co-domesticated life, with the simple-minded and kindly-hearted, and devout people of India—India of the Hindus. There is a belief in India, and 'the East Indies' generally, that this lizard causes morphew, a leprous eruption of the skin, and again that an electuary of it is a cure for morphew; and its Arabic name *samibras* [*samm* 'poison,' *abras* (against) 'leprosy'] is founded on this belief. The Greeks and Romans held a similar belief, derived aboriginally no doubt from the East, and then taken back to the East through the Arabian writers on medicine, at second hand from the Greek and Latin writings on plants, "Materia Medica," and natural history. Compare Pliny *N.H.* viii.-49 (32), xxix.-23 (4), and xxix.-38 and 39 (6). In viii.-68 (39) he describes an Indian lizard of the Himalaya [Mount Nysa] twenty-four feet long, and coloured in purple, and yellow, and azure. Mr. Kurup's paper, indeed, presents us, virtually, with the whole contents of 'the Lizard (*Gauli*) Shastra,' and that, 'nota scienter,' is the value, and enduring value of it. Also note well throughout it, the popular Indian dread of 'the police.' His one omission, quite venial, is that he has not sufficiently enforced the fact that the interpretations of the vagaries of the *chipki's* daily life in a blameless Hindu's house, have to be modified by the observer's position in 'the points of the compass,' in relation to the ominous lizard; and by the time of day ['light' or 'dark'], the half of the month ['light' (waxing moon) or 'dark' (waning moon)]; and the period of the year ['light' (spring and summer), or 'dark' (autumn and winter)]; complications that serve the purpose of always justifying the lizard and the astrologer—whatsoever the event. Mr. Kurup's sin of commission is his superior way of sneering [into which he has been betrayed by his English education] at the ignorance of his fellow-countrymen, who still live joyfully with their gods, and in the beliefs of their wise, and wary, and right worshipful forefathers. But I do not press that point: only asking such writers to remember:—

Your laughter has killed more hearts than ever were pierced with swords.
Ever you daub new mirrors and turn the old to the wall;
And more than blood is lost in the weary battle of words;
For creeds are many; but *Truth* is 'One, and contains them all.'"]

* See *Journal*, February 24th, 1911.

It is known to the wide world that there existed in India, in past times, all sorts of so-called superstitions. But it may not be so well known that they continue to flourish not less in number to the present day. But it is some consolation to know that all the educated classes of India are having their eyes opened to the error of these foolish beliefs.

My present object is to bring before readers of the *Journal* a *précis* of the *Gauli Shastra*, which deals with predictions from the falling of lizards and the chameleon. The belief in these predictions is general throughout India, but prevails particularly in Southern India, where the Dravidian Hindus are supreme. The following is an abstract of these predictions as given in the *Gauli Shastra*. I myself have little faith in them; and I send you the whole of them because a good gentleman, who is regarded as a great authority on the subject, professes to have had the truth of some of them demonstrated to his satisfaction. I give the abstract in a tabular form.

If a lizard or a chameleon falls on	the result is :—
Hair	Comfort.
Right cheek	Meeting a friend.
Lock of hair	Illness.
Tip of hair	Loss.
Crown of head	Death.
Forehead	Wealth.
Middle of eyebrow	Loss of wealth.
Right eye	Good to family.
Left eye	Arrest by police.
Mouth	Hearty meals.
Nose	Anxiety.
Right ear	Wealth.
Left ear	Sorrow.
Lower lip	Gain.
Upper lip	A row, or a fight.
Between lip and chin	Death.
Neck	Arrival of a relation.
Right shoulder	Success.
Left shoulder	Defeat.
Hand	Loss of wealth.
Between wrist and elbow	Gain of jewelry.
Back of hand	Loss of wealth.
Finger	Arrival of a friend.
Nail	Loss of wealth.
Palm of hand	Discomfort in family.
Back	Secret information.
Ribs	Meeting of a relation.
Stomach	Wealth.
Breast	Comfort.
Paps	Good luck.
Nipple	Hearty meals.
Armpit	Connubial bliss.
Right hand	Fame.
Left hand	Disgrace, sorrow.
Wrists	Loss of wealth.
Waist	Gain of dress and jewelry.
Abdomen	Illness.
Below abdomen	Fame.
Below that	Death.
Rectum	Illness.
Thigh	Loss of dress.
Knee	Arrest by police.
Below knee	Loss of wife or husband.
Foot	Arrest by police.
Heel	Death.
Big toe	Comfort.
Toes, or toe	Loss of a bow.
Nail of toe	Loss of cattle.
Sole of foot	Ruin.
Bed	Bad luck.
Chair, or chairs	Good luck.
Empty plate	Love.
Cooking pie	Loss of wife or husband.
Temple (or church), while at worship	Death of ruler.
Public meeting	Death of chairman.
Two friends talking	Bad luck for better man of them.
Two persons fighting	Victory for weaker.
Light, extinguishing it	Overwhelming misfortune.
Carriage	Journey delayed.

A lizard falling on the stomach of a wife indicates an addition to the Family.

Also, if a lizard falls on any of the Family five days before Full Moon, it means an addition to the Family; if four days before that, added wealth, as well as an addition to the Family.

If a lizard fall on the Monday, Wednesday, Thursday, and Friday of a week, there will be money in it; if on the Sunday, Tuesday, and Saturday of a week, loss of money.

Lastly, if the cry of a lizard or chameleon is heard from the Zenith, or from due East, West, or North, we shall be successful in whatsoever we may be thinking of, or doing, or whithersoever we may be going; if from the South—the Kingdom of Yama,—Death. The cry heard from South-East means wealth; from South-West, sorrow; from North-East, difficulty; and from North-West, travel in distant countries.

THE LONDON MEETING OF THE INTERNATIONAL SOCIETY FOR THE PROMOTION OF COMMERCIAL EDUCATION.

From July 24th to August 12th some two hundred students took part in this meeting, zealously attending three lectures each morning, and paying visits in the afternoons to factories and commercial undertakings.

The International Society organising the meeting has been mentioned in previous numbers of the *Journal*. Its headquarters are at Berne, in Switzerland; its President, Monsieur A. Junod, is the Federal Inspector of Swiss Commercial Education. The Society is very active in collecting and circulating in its *Review* much valuable information respecting commercial teaching and the progress of commercial education throughout Europe, but it is best known, probably, by reason of the yearly courses of lectures on commerce which it arranges. The London meeting is the fifth of these, the successor of meetings at Lausanne, Mannheim, Le Havre and Vienna. The aim of the meetings is to give a practical course of lectures on the commerce and industry of the country in which the students are assembled; theories and history are excluded, and attention confined, as far as possible, to the existing conditions of trade, to the prevailing methods of business, the commercial prospects, and the industrial developments within a particular sphere—last year within Austria, this year within Great Britain. Next year the meeting will be at Antwerp, and Belgian commerce will be treated from this same practical standpoint.

The London meeting, which closed on the 12th inst., has been in many ways an epoch-making one for the Society. In the first place, it was attended by over two hundred students; one hundred was the largest number at any previous meeting. Secondly, there were representatives in London from countries never before represented. China sent four students; four came from Greece; a Chilian professor was specially sent by his Government; Englishmen were present for the first time, while a New Zealander and a Canadian were also the first to come from their respective countries to the International Society's meeting.

As to the rest of the audience, Germany, Switzerland, and Belgium sent the largest number of students, while Sweden, Norway, Holland, Russia, France, Austria, Hungary, Italy, Finland, and the United States contributed a proportion of the students. About a dozen ladies were present.

In the third place, the London meeting was a new departure in respect to the afternoon visits. These are an important part of the course, illustrating the matters treated in the morning lectures. Never before had it been necessary to break the students up into small parties for the visits. At previous meetings the whole body of students were able to go together to visit commercial undertakings, and some disappointment was at first expressed when the two hundred members of the London meeting learnt that they could not go in a body to the Bank of England, or the Mint, or to the warehouses and factories which were visited. However, the organisers of the course were able to arrange a number of excursions for each afternoon, and generally satisfied the students, though the latter were sometimes in doubt as to their choice of entertainment. On one afternoon, for instance, there were six different parties, and a student had to decide whether he would go to the bindery of the Oxford University Press, or to Messrs. W. & A. Gilbey's wine cellars, or to Pitman's Metropolitan School, or Messrs. Henry Tate & Sons' sugar refinery, or would see the *Daily Mail* printed at Carmelite House, or jam made at Messrs. E. & T. Pink's factory.

Besides the afternoon visits in and around London, excursions were made to Northampton and to Birmingham, where typical factories were visited, and a third day was given up to a river trip from the London Docks to the mouth of the river, and back to Blackwall, visiting the Albert Docks on the way.

This trip was arranged by the Port of London Authority, who lent the "Conservator" for the occasion. The Authority were very good friends to the students throughout, allowing no less than six different parties to visit the warehouses of the London Docks. The organisers of the course were particularly grateful for this, for every student was eager to visit the warehouses, and in the end almost all were accommodated.

Another good friend was the General Post Office. The Postmaster-General was one of the first members of the London committee of the International Society; Mr. Robert Bruce, Controller of the London Postal Service, gave an excellent lecture on the work of the Post Office, and after the lecture six parties of students, about one hundred and eighty in all, visited the General Post Office and the sorting office at Mount Pleasant. The Education Office of the

London County Council also showed a most gratifying interest in the society's meeting; on the first afternoon of the course the students were divided—with no little labour for the organisers—into twelve parties, which paid visits to typical Council schools in Hampstead, in Central London, in the Borough, and even in Forest Hill.

I have mentioned some of the factories which were visited. Messrs. Peek, Frean & Co.; Messrs. Doulton & Co.; and Messrs. Watney, Combe, Reid & Co., also received the students in a most generous manner. The Great Eastern Railway at Stratford, and Messrs. James Carter & Co. at Raynes Park, were also particularly kind, but to the great disappointment of the organisers many of the students missed their train for this last visit, and did not avail themselves of the interesting and hospitable preparations made for them.

Such mishaps were only to be expected; the students gallantly sat through their three lectures each morning in spite of the intense heat; they were generally ready to miss their lunch and rush off to their afternoon's destination, but towards the end of the three weeks' course, some slackening in their zeal was but natural.

However, they all had their share of commercial and industrial sight-seeing, and all expressed their gratitude for the reception they were given on each occasion. What they saw was of the best. The organisers discovered early in their work that only the best factories were ready to admit foreigners without fear or suspicion; they came to know that a refusal was certain from a firm not in the first rank.

No mention has been made of the lectures, as many have appeared in the daily press,* and the Society hopes to publish a collection which will comprise almost all the forty-five that were delivered. The lecturers were foremost men in their particular lines, combining an excellent delivery with first-hand practical knowledge of commerce and industry.

A word may, however, be said as to the lessons of this meeting. Here were two hundred foreign students—there were but half a dozen Englishmen among them—mostly teachers or pupils at the Continental commercial academies, institutes, etc., who willingly sacrificed their short vacation to go through this exceptionally strenuous course. Moreover, many of them do it year after year; those who have been to one of these meetings seldom fail to come regularly in subsequent years to the succeeding meetings. Without entering into any discussion upon systems of commercial education, one may ask whether such a movement as this should not commend itself to all students of business and industry. Can we not find young men in this country whom we may profitably send to the meeting and lectures at Antwerp next year? The International Society was hardly known when it began to organise this London meeting some seven months back. Had it not been for the invaluable start given to it by Sir Henry Wood (of the Royal Society of Arts) it is difficult to see how the meeting could ever have been arranged. Thanks to him, and to a few friends who from the first appreciated the work of the Society, the London meeting was arranged and went off most successfully. But it would be false to pretend that the Society had been well received by commercial societies generally in England. One hopes it is merely that they are conservative, and may still take an active part in the work of the International Society. At the close of the meeting, the delegates of the Society were entertained at lunch by the Government, an entertainment which to some extent brings the British Government into line with the twelve leading Governments of the Continent, which, however, not only patronise but also subsidise the Society. Mr. Tennant and Lord Brassey both spoke favourably of the work of the Society, while regretting the small share which England had hitherto taken in its affairs. The President of the Society, in replying, expressed his earnest hope that at future meetings the young English students would be as numerous as those from Germany and Switzerland. His wish must be echoed by all who are interested in commercial education, whatever their particular theories on that thorny question.

E. Cleveland-Stevens,
Secretary of the London Meeting of the International Society for the Promotion of Commercial Education.

* A report of Mr. Frederick Huth Jackson's lecture on "The Bank of England" appears in the next column.

THE BANK OF ENGLAND.*

By the Right Hon. Frederick Huth Jackson,
President of the Bankers' Institute.

The original charter of incorporation of the Bank was granted as far back as 1694, but the real

* This report of a lecture delivered in the House of the Royal Society of Arts to the members of the International Society for the Promotion of Commercial Education is reprinted, with the Editor's permission, from the *Financial Times*.

history of the institution as it is to-day dates from the Bank Charter Act of 1844, carried at the instance of Sir Robert Peel.. The years immediately before 1844 were years of trouble, and of recurring financial crises; and it is generally admitted that it was partly owing to the failure of the Bank of England Directors to observe a due proportion between their issues and the bullion in their vaults that these crises had been so severe and disastrous. The main principle of the Act of 1844 was the complete separation of the business of issue from the business of banking. The form in which the Bank's accounts, both of banking and of issue, were to be published, was laid down; but while in the business of banking the directors were left complete discretion, the business of issue was strictly regulated, and no discretion was given to the directors at all. As far as they were concerned, the business of issue might have been under the control of the National Debt Commission or any other body of officials worthy of trust. Up to an amount of £14,000,000 notes could be issued by the Issue Department against securities; beyond that amount no notes could be issued except against coin and bullion, of which one-fourth might be silver. I have often heard it said that the limit of £14,000,000 for the fiduciary issue was fixed because it was found that in the year previous to 1844 the amount of notes in circulat on had never been less than £16,000,000, and it was therefore assumed that the limit of £14,000,000 was a safe one. It has certainly proved so. If any of the country issues should lapse, it was provided that the Bank of England could increase its fiduciary issue by two-thirds of such lapsed issues. Under this provision of the Act of 1844 the fiduciary issue of the Bank has been gradually increased to its present limit of £18,450,000.

This Act was a triumph for the advocates of the currency theory over the advocates of the banking principle. At that time, and for many subsequent years, the fight between these two parties continued unabated. The financial crises of 1847 and 1857, following so soon after the Act of 1844, kept this dispute alive; but one does not hear of it any longer, and one is glad to think that, whatever criticisms may nowadays be levelled against this Act, they are no longer questions of principle or theory, but of practice. The Act was to continue in force for a period of ten years, and was then to be subject to twelve months' notice on the part of the Government, and to the repayment of the Government debt of £11,015,100. Acts have since been passed amending the Act of 1844 in certain details, but the main principles of that Act as outlined above have not been disturbed. By this same Act no other bank could issue notes within a radius of sixty-five miles of London, and Bank of England notes were made legal tender in England and Wales. The main criticisms made nowadays against the Bank Act are two. It is first of all maintained that the gold reserve of the Bank is too small, considering the enormous amount of banking deposits of the country. It is suggested, therefore, that the fiduciary issue should be gradually reduced and replaced by gold. It would undoubtedly be a more satisfactory state of affairs if the whole of our note issue were based on gold. But who is to pay for this? It would cost at least 3 per cent. per annum on the amount involved—or £555,000 a year. Among the chief advocates of this idea are some of the joint-stock banks; but I cannot learn that they are willing to bear the cost of it. The Bank already keeps an average reserve in cash against all its liabilities of 40 to 50 per cent.—or about three times more than the joint-stock banks do. As the Bank of England has its own shareholders to consider, it would not be fair that they should be mulcted in this extra expenditure. There only remains the Government. By the Act of 1844 the whole of the profits of the Issue Department of the Bank of England, after making a reasonable allowance for the Bank's remuneration, go to the Government, and from this source it receives an annual income of over £180,000 a year. It would not only have to sacrifice this and incur the above-mentioned additional charge of £555,000 a year, but would also still have to pay the Bank of England the cost of manufacturing and issuing the notes. Would it be unreasonable to estimate the loss to the Government at a million a year? I think not; and I doubt if any Chancellor of the Exchequer would be prepared to face this proposition.

The Use of Cheques.

The fact is that nowadays the circulating medium in this country is not bank-notes but cheques. The best illustration of this is the Bankers' Clearing House returns. The average daily clearings have risen from £11,000,000 in 1868 to £48,000,000 in 1910. What have been the figures of the bank-notes in the hands of the public during the same years? In 1868 the average note circulation was £24,000,000, in 1910 it was £29,000,000, and this in spite of the enormous increase in the wealth and business transactions of the country in the interval. I think the conclusion is obvious: that those who provide the circulating medium should provide its protection.

The second criticism of the Bank Act is that we should adopt some such provision as the Germans have—that the fiduciary issue could be increased, on payment of a certain fine to the Government. I admit that the present position is illogical. It is not, I suppose, disputed that, if a severe financial crisis were again to occur the Chancellor of the Exchequer would indemnify the Bank for exceeding the legal limits of its fiduciary issues. Why, then, not provide some legal machinery for such an eventuality? The only answer is that I do not think that, in practice, it has worked well in Germany. It has resulted in an habitual exercise of this excess power, without any particular regard to the acuteness of the situation. I prefer our own method, however illogical it may be. We have not required to appeal to the Chancellor of the Exchequer for forty-five years;

and I have every hope that we may be able to avoid approaching him for another forty-five years.

I now come to what is, nowadays, the most important function of the Bank of England—its position as provider of the emergency currency of the country. The currency of this country is no longer bank-notes or even gold, but cheques. These cheques are issued against credit balances with the various banks, on which the cheques are drawn, and at times the banks find that the amount of the cheques drawn—especially when dividends are being paid—brings the amount of their item of "cash in hand and at the Bank of England" dangerously low. It is not a question of actual cash, as most of these cheques and dividend warrants are paid through the clearing. The object of the banks, therefore, is not to replenish their tills, but to replenish their balances with the Bank of England. They all of them have large amounts of money lent out on the money market at call. These they proceed, simultaneously, to call in. The borrowers find that the money that one bank calls cannot be obtained from any other bank, and they are, therefore, compelled to go to the one remaining source of supply, the Bank of England. They borrow there practically the same amount that the bankers have called from them. No actual money passes; the whole thing is done by transfer at the Bank of England. Now, that happens every quarter. It occasions no disturbance—except to the money-brokers—and is habitually carried through without the slightest hitch. Subject to certain reservations, the market knows that nowadays it can always get at any time the accommodation it requires from the Bank of England. The rate for advances is now ½ per cent. over Bank rate, while the rate for discount is Bank rate. One can truly say that everybody in the money market can nowadays, directly or indirectly, obtain advances from the Bank of England, provided he can tender the class of security which the Bank requires. It is still thought by many people that the Bank of England fixes the rate of discount. This is entirely erroneous—the Bank rate attempts to conform to what is the actual value of money in this country. The only effective means we have of attracting gold from abroad is by raising the rate of discount.

PROGRESS IN EGYPT.

Each succeeding annual report on the administration of Egypt and the Soudan attracts increasing attention, and this is mainly attributable to the fact that it bears so unmistakably the personal stamp and touch of the Administrator. It is a plain tale of aims and achievements in every department of government, but the detailed records are obviously prepared for submission to the central controlling authority, and the hand of the chief is perceptible throughout; hence the whole story is characterised by a due restraint and sense of proportion, which combine to present a thoroughly harmonious picture on the whole. The effect is far more pleasing and convincing than, for instance, in the case of the Indian Administration reports, where the impression produced is more or less that of a vast aggregate of patchwork, and where any comments or reflections on *la haute politique*, or on some of the chief social, military, or other vexed problems of the day would be rigidly barred. We do not know whether it may not be possible in the future to induce the Indian Viceroy of the day to write an account of his stewardship on every 31st of December, for submission to the British people, but there can be no doubt such a paper would engage public attention and rivet people's thoughts far more effectually than any of the colourless and belated Indian Blue Books at present produced, with so much lingering and travail, whether at Calcutta or Westminster.

In his last report, the late Sir Eldon Gorst plunged, at the very outset, into a highly controversial topic—the foolish and violent manifestations of Anglophobia, which culminated in the rejection of the Suez Canal scheme by the General Assembly, and the outburst in a section of the English press, which professed to see an impairment of British authority and demanded more or less violent measures in consequence. Sir Eldon made a fairly good defence, reminding his readers that it had been proclaimed over and over again, almost *ad nauseam*, that British policy in Egypt is not merely to give Egypt the blessings of good administration, but to train the Egyptians to take a gradually-increasing share in their own government.

From the time of his appointment, Sir Eldon Gorst endeavoured (1) to encourage the Egyptian ministers and officials to take more responsibility and initiative in the affairs of the country; (2) to give the Legislative Council and the General Assembly, although they are not really representative of the country, an opportunity of making a non-official voice heard in matters of importance; and (3) to develop and give powers to the provincial councils, enabling them to be a real factor in local government, especially as regards education. Of these (1) and (3) have shown successful and encouraging results, but both the Legislative Council and the General Assembly displayed, in 1909 and the first half of 1910, an increasing tendency to become instruments of the so-called Nationalist agitation against the British occupation. Anonymous attacks were made on the Government in connection with the budget and the Soudan, and the unreasonable hostility and suspicion displayed in the discussion of the Suez Canal scheme were in their essence manifestations of Anglophobia stirred up by the Nationalist party. Instead of the Legislative Council contributing, therefore, to further the task of government, the aim of the intolerant majority was to render this impossible, and the moderate minority, if there was one, allowed itself to be dominated and extinguished by the extremists, the whole Council thus utterly failing to perform the functions assigned to it in

the constitution devised by Lord Dufferin. The Ministers are, of course, chosen from among the most capable Egyptians, and are better acquainted with the real desires and opinions of their countrymen than the members of a Council who, in reality, represent nothing but the class of wealthy Beys and Pashas, and are, moreover, unable to withstand any spurious agitation manufactured by a few interested parties. Institutions really representative of the people are obviously impossible in a country in which, out of a population of over 11,000,000, only 600,000, or less than 5½ per cent. can read and write.

As to the assassination of the late Prime Minister, and the eventual execution of the criminal, though some unfavourable criticism was heard in England, the time occupied in the various stages of the inquiry and trial happened to be unusually short, i.e., two months. Sir Eldon considered that on the whole it was a most favourable augury for the future of Egyptian justice that it proved itself able, in a matter where immense efforts were made to pervert the course of justice, to deal with the case in a calm and impartial spirit.

Turning to the more material results of administration, we seem to miss some information that might be useful under the head of Railways. It is gratifying to note that the net earnings were substantially larger in 1910 than in the previous year, but it would be instructive to be told how far the mileage of railways has increased during the British occupation, and what further developments are contemplated, for railways, as we all know, are a pretty sure index of national progress.

Under the head of Agriculture, one of the most interesting events was the appointment of a commission to investigate questions connected with the growth of cotton in Egypt, and a noteworthy result of this commission was the creation of a special Department of Agriculture, with the starting of experimental farms and practical schools of agriculture.

Important reforms have also been carried out in the well-known El-Azhar University and other Mohammedan religious institutions, considered to be outside the sphere of the European officials. Hitherto want of support and encouragement from the Egyptians themselves has been a stumbling block to any progress in this direction, but thanks to the hearty support of His Highness the Khedive, and the Legislative Council, the reforms initiated and elaborated by the Egyptian Ministers have been carried through, and the fact that the prejudices and innate conservatism of the old-fashioned type of Moslem have been overcome by methods of peaceful persuasion, is a hopeful sign for further progress.

BUSINESS METHODS IN CHINA.

In his report on the trade of Canton for 1910 Mr. Acting Vice-Consul R. S. Pratt makes some interesting remarks as to European methods of conducting business in China. "Signs are not wanting," he writes, "that merchants and manufacturers in the United Kingdom have succeeded to a considerable extent in revising their ideas of the exploitation of the China market. Until comparatively recently they were content to apply to local firms, acting as their agents, and to supply them with elaborate catologues which, framed for the European market, were practically unintelligible to prospective purchasers in China, and whose only use was to keep the local agent better informed of recent developments at home. What was wanted was an attractive display of samples, with brief descriptions in Chinese if necessary, and competent travellers—not necessarily Europeans—to bring such samples insistently to the notice of native dealers. This is being realised, and certain foreign firms are opening showrooms for machinery and the like in important trade centres, while other firms have for some time past sent foreign travellers, accompanied by good interpreters, to various inland marts, and have found their enterprise rewarded. The use of advertisements, too, is being greatly extended, and few Chinese cities on the main routes do not display an assortment of highly-coloured Chinese posters.

"The native newspapers — the number of which, already considerable, is constantly increasing — afford another excellent medium for bringing goods to the notice of native buyers, and they are well patronised by the sellers of foreign wares.

"A prominent firm is at present making an interesting experiment, the advantages of which it is still too early to estimate, in employing university-trained men, at salaries considerably higher than those heretofore current, to act as agents and travellers. The Oriental is a keen admirer of education, and is quick to discern whether a man is well-educated or not, and it is important that those who come into contact with him should be men that he can respect.

"It should, however, be remembered that the standard of living in China is much lower than in European countries, so that a large proportion of articles manufactured in Europe is quite unsaleable here. Until the development of industries in China has reached a stage considerably in advance of its present one, the market for machinery must be limited to those machines suited for domestic pursuits, or, at the best, very small factories. It is useless for manufacturers to look to China for a market for elaborate agricultural machinery, motor-cars, labour-saving devices in the spinning and weaving trades, etc., as, in the case of motors, there are practically no roads fit for use, while the machinery is quite out of the reach of the Chinese labourer. On the other hand, sewing machines, glass lamps and lampware, patent medicines, cigarettes, condensed milk, etc., find a ready sale, but must be cheap. It is often found that the superior but dearer British article cannot compete with the cheaper one from the Continent, but still less with the Japanese imitation, the first cost

being a more urgent question with the average Chinese than excellence and durability.

"Many manufacturers write to various Consuls in China asking to be placed in communication with some firm likely to be willing to act on their behalf for the sale of their goods. It is, however, but too often the case that the manufacturers expect the local merchants to buy a range of samples or a quantity of their goods to put before the native merchants. The local merchant is naturally unwilling to invest his money in what is necessarily a speculation, and no business results. Manufacturers in the United Kingdom would find that a little more accommodation on their part when new fields are being opened up would produce results more than proportionately favourable."

A FRENCH STATE COMMITTEE ON THE HYGIENIC ASPECTS OF LIGHTING.

The French official Gazette *L'Officiel* for June 16th, announces that a Committee dealing with the Hygienic Aspects of Illumination has been appointed by the Minister of the Interior in France.

The objects of the Committee, as outlined in the announcement, cover a wide ground, including the general effects of illumination on health, the framing of simple rules as to the best means of applying customary systems of lighting to various industrial operations, the nature and causes of short sight and impairment of vision, and their connection with defective lighting conditions, the study of methods of measuring illumination, etc. In investigating these different questions conjointly the Committee should accomplish much valuable work. In the past the difficulty has sometimes been that recommendations on lighting were made by those interested primarily in the physiological and hygienic questions, but without an adequate knowledge of the measurement of illumination or *vice versa*. It is therefore satisfactory to observe that this Committee receives the support of a number of prominent authorities on hygienic matters, gas and electrical engineers, inspectors of factories, and others interested in various aspects of industrial lighting.

Although reference to the question of industrial lighting has been made in the reports of H.M. Inspector of Factories, and in the recent report of the Departmental Committee on Accidents, there can be little doubt that the subject has not yet received as much official attention in this country as it deserves. A great deal of useful work has been done by the Illuminating Engineering Society—quite sufficient to show what an important part effective lighting plays in the conservation of vision and the prevention of accidents, and quite sufficient to warrant us in following the example of France and bringing the whole subject under State supervision.

HOME INDUSTRIES.

The Yorkshire Penny Bank.—For some time past there has been uneasiness as to the position of the Yorkshire Penny Bank, an institution founded in 1859, and doing a very large business on exceptional terms. The bank has a great number of branches in the north, and its clientèle is almost entirely amongst the poorer classes of depositors. The bank suffered, as all other banks have suffered, but in a peculiar degree, from the depreciation in high-class securities, and the collapse of the Birkbeck Bank has led to the withdrawal of deposits on a scale that gave the managers of the bank cause for anxiety. The balance-sheet made up to December 31st last showed that the position of the bank was not entirely satisfactory at the close of 1910, and it has worsened since then. Happily the great banks have come to the rescue, and have agreed to subscribe a sum of £2,000,000 in order to form a new company to be called "The Yorkshire Penny Bank, Limited," having a capital paid up to the extent of £750,000, a reserve fund of £750,000, and an uncalled capital of £500,000, which has provisionally agreed to take over the liabilities and assets of the Yorkshire Penny Bank. A second group of banks have agreed to give guarantees to the new company for a very substantial total, to provide for the possible future depreciation of securities beyond an agreed amount. The old directors will be upon the new board, with additional ones to represent the banks which have come to the rescue, and the members of the staff of the Yorkshire Penny Bank will remain connected with the new bank. It is significant of the soundness of the Yorkshire Penny Bank that the other banks pay for the shares they receive in the new concern a premium of £3 per share. There is no shadow of censure upon the old management. The funds of the bank were invested in the best possible securities, and great judgment was shown in making advances, but by its constitution the bank was bound not to make profits, and consequently it charged too little for its advances and paid too much for its deposits. It was an unusual limitation, but there it was, and until removed had to be acted upon. The result was that not only was the bank without capital, but it was without adequate reserves for times like these when no class of security is safe from depreciation. The arrangement now arrived at puts the position of the bank beyond cavil, and those who have come to its rescue deserve the thanks of the community. But the day of the institutions which have done so much for thrift on the lines of the Yorkshire Penny Bank seems to be passing. The great banks are trying to get into touch with the poorer depositor. Much of the business of the Birkbeck Bank has been taken over by a great banking institution, many others have now interested themselves in the Yorkshire Penny Bank, and it may be expected that other similar institutions will soon cease to be independent entities. The fall in the value of high-class securities is rendering their extinction

inevitable, and the transfer to stronger hands will be to the advantage of the community.

Pit-Brow Women.—The following amendment to Clause 93 of the Coal Mines Bill was carried by only a small majority in the Grand Committee: "No girl or woman other than those employed on or before the first day of January, 1911, shall be permitted to be employed above ground on any mine, provided always that this section shall not apply to any woman engaged in the cleaning of colliery offices, or for any other like purpose." This suggested alteration of the law is strongly opposed by the women and girls concerned, and a deputation of them has been on a visit to London to protest against it. The probabilities point to Parliament rejecting the amendment, and it is to be hoped it will. It is argued by its author, Sir Arthur Markham, and others, that the law prohibiting the employment of women underground ought to be extended to the employment of women above ground on mines, but the considerations which apply to the one case are not applicable to the other. The main argument against the employment above ground is that the work of separating the stone from the coal—the work of the pit-brow women—is hard and unpleasant. Is it pleasanter for the domestic servant to toil upstairs from cellar to drawing-room, with great buckets of coal? The pit-brow work is thus described by a correspondent: "The number of women employed at each pit varies from twenty-five to ninety, and the great majority of them are engaged in sorting coal. In this occupation an endless band from a yard to two yards wide passes slowly along between two lines of workers. It carries coal of different sizes, from cobs to large nuts. It is the duty of the women, as the coal passes, to pick out stones and shale and throw them aside. These workers are stationed on high covered platforms, or really wooden rooms, with more ventilation and apertures than ordinary workshops. As the coal comes up from the pit mouth it is screened by machinery, the slack and small coal being removed before it reaches the women, and as it leaves them it falls into railway waggons on the line underneath, or into tubs." The women work some eight or nine hours a day, except on Saturdays, or in slack times. They begin at six and finish between three and four. In ordinary times they earn from ten shillings to twelve shillings a week, and the workers are more frequently girls than women. No doubt it is a dirty occupation, but collieries vary in dustiness, the workers no longer wear men's clothes, and improved methods and machinery have done much to make the work less disagreeable. And that it is not unhealthy is demonstrable. Dr. Cooke, of Aspull and Haigh, who speaks from an experience of thirty years, says that morally the pit-brow women are at least equal to any class of indoor woman worker, and that physically they are much superior. The coal dust does not appear to be injurious, there is very little sickness among them, and accidents are rare. Many girls who have been forced to leave the mill through ill-health have actually been restored to health on going to work at the pit-head. At one of the pits at Coppal a woman of seventy-one years is still working, and it is believed she has been at "the brow" for over half a century. There are some 3,000 women and girls employed at the pit-brow in Lancashire. About 1,200 are at work in the Wigan district, 1,000 in the Bolton district, and the remainder are distributed in various mining centres in the county. The displacement of so many workers would cause much distress to the families directly concerned, and it is a very serious matter to close to women any respectable employment.

Textile Mill Driving.—Some uneasiness has been caused by the composition of the committee appointed to inquire into the relative merits of electricity and other modes of driving in textile mills. Certain members of the committee are manufacturers of the plant whose merits are to be examined. They will, therefore, be to some extent judges as well as advocates, but a greater difficulty will arise when a manufacturing member of the committee examines the methods of a rival in the same industry who may or may not be on the committee. It is not to be expected that one manufacturer will be ready to give his best technical information to the managing director of another firm, who could hardly be relied upon to limit his use of it to his report only. It is suggested that the difficulty might be got over by arranging that manufacturing members of the committee should only act as witnesses to their own work, leaving the task of collating the testimony of other firms to members who are not in that particular industry.

Two Great Brewing Companies.—The brewing industry has fallen upon evil days. Increased cost of raw materials and increased taxation, coupled with the growing temperance of the nation, have seriously reduced the profits of nearly all the great breweries, but one stands out from the rest in the continuity of its expansion and profits. Messrs. Arthur Guinness, Son & Co., are the largest brewers in the world, and from the outset of their career they have been highly prosperous. For the year 1910-11 the dividend has been raised from 15½ per cent. to 16½ per cent., the increased amount requiring an additional £50,000. An extra £60,000 is placed to reserve, and although £50,000 less is appropriated to depreciation, nearly £33,000 more is carried forward. The net earnings for the past year rose by nearly £100,000, following an increase in 1910 of £149,000. The ordinary capital was duplicated in 1908 by the issue of a bonus of 100 per cent. in stock, so that on the basis of the former capital the present dividend is 33 per cent. The ordinary stock is quoted at 445, at which the yield to a purchaser is only a trifle over 3⅝ per cent., allowing for the increased dividend. The nearest English brewery in importance to the great Irish concern is

that of Messrs. Bass, Ratcliff & Gretton, but although its position is very strong it has not passed in the same triumphant way through the troublous times. In a prospectus issued in January 1888, it was stated that the audited profits during the five years to December 1887 showed average annual net profits exceeding £340,000. In the past four years the average works out at about £275,000 per annum, but for the year ended June 30th last, the net profits were £295,773 as against £278,578 for the preceding year. In 1908 it was considered wise, having regard to the proposals affecting the trade, and the serious position arising therefrom, to write off from goodwill the sum of £560,000, reducing it to £800,000, this being taken from the reserve, and in view of recent legislation the directors have caused the whole of the licensed properties and loan securities of the company to be valued, and the amount written down under this head is £503,077 19*s.* 8*d.*, which has also been transferred from the reserve fund. The "B" debenture stock yields, at the current quotation of £70, £5 0*s.* 4*d.*, and the preference stock at £92, no less than £5 9*s.* 2*d.* per cent. An increase of 1 per cent. is made in the ordinary dividend this year, making the distribution 8 per cent., and probabilities point to a further increase in the dividend next year.

CORRESPONDENCE.

IMPERIAL COLONIAL DEVELOPMENT.

Captain Collins has sent me a copy of the *Journal of the Royal Society of Arts* of April 14th, 1911, containing his paper on Australia. I know Australia from north to south, and east to west, having done a two years' overland trip there.

I noticed in the *Journal* a letter, written by Mr. C. R. Enock, F.R.G.S., which interested me greatly.

I cannot agree with the policy that Mr. Enock advocates, viz., the granting of Crown lands to British municipalities. To make a grant of land, however fertile, for the purpose of settling British artisans on it, especially in the far-off northern territory, would be to court failure. To be a farmer requires an apprenticeship just as much as any trade.

A British municipality would stand a very poor chance of establishing a successful colony in the northern territory, unless they had the help of a great number of expert Australians.

Those who emigrate at present mostly start work on well-established Australian farms, and thus become acclimatised under the best conditions. New South Wales, Queensland, and West Australia, have well-organised systems of immigration, and it would be very unwise for even British municipalities to try to improve on them. Mr. Enock thinks that present conditions of emigration are too hazardous. For the sum of fourteen guineas a person is conveyed a distance of thirteen thousand miles, and fed and housed for forty-two to fifty days. There is really nothing very hazardous about that when you are placed in a civilised country at the end of your journey—yes, and a country where a man who is adaptable can make a decent living. Contrast this with the really hazardous undertaking of emigrating forty years ago.

Australia welcomes all; there is room for millions; money is not required; grit and determination are the only essential qualifications.

ALAN G. REID.

Obuasi, Ashanti, Gold Coast Colony,
July 13th, 1911.

Mr. Enock, to whom the foregoing letter has been submitted, writes in reply:—

It is evident that Mr. Reid has not grasped the purpose I advocate in the endowment of our British municipalities with areas of Colonial lands, just as others have not. No one with any knowledge of the subject would propose the implanting on the northern territory of Australia, or anywhere else, of inexperienced people, and expect them to work out their salvation by cultivating the soil. The purpose is to allocate such areas of territory in order that they may be a tangible property for British ratepayers; to be developed scientifically and systematically in their interests, forming a field of activity for their surplus workers under organised conditions—not only land-workers, but artisans—centres which would work in conjunction with the parent centres at home, who would establish them. It is to future generations as well as to that of to-day that this benefit would accrue.

As to emigration being hazardous, Mr. Reid states that emigrants can reach Australia for fourteen guineas. But the great bulk of our poor class, who would be benefited by emigration, never had fourteen guineas in their lives! Further, what are they to do when they get there, under present conditions? It is useless to send them out haphazard to flood colonial labour markets. It is all very well to say that Australia is a country where a man who is adaptable can make a good living, but the great bulk of our poor and workless are probably not adaptable, or not without proper organisation. They are valuable assets of labour, for whom there is not sufficient scope under present conditions, but who, under organisation such as that of which my proposal forms part, would be producing units. As I have pointed out in the last of a series of articles in the *Review of Reviews*, August (*q.v.*), legislation at home now is favourable to the "back to the land movement." And Canada and Australia are not likely to obtain in the future a large supply of our land-working people. It is therefore to the benefit both of the colonies and the homeland to set about making organised use of the surplus town element. I have gone into the matter in my forthcoming paper this month before the British Association.

C. REGINALD ENOCK.

Northwood, Middlesex, August 9th, 1911.

CANTOR LECTURES ON "ETCHING."

I think it only right that some protest should be made concerning Mr. F. Wedmore's Cantor Lectures on "Etching," printed in the *Journal* of the 11th inst. These lectures are supposed to be delivered by authorities on their subjects. I am totally unaware upon what grounds Mr. Wedmore has any claim to be considered an authority. He is not an etcher—and he proved by the lectures he delivered that he knew little historically. The person who would devote half a page of the *Journal* to Bega—of whose etchings I am blankly ignorant—while dismissing Piranesi and Van Dyke in four or five lines, has a quaint idea of things; but as he has omitted Callot altogether his historical knowledge is quainter. But that does not equal his ignoring Turner, whose name is never mentioned. After that his critical conclusions and contentions and appreciations have little value.

But there is still less excuse for the list of moderns he sets up for us to admire, and no excuse for his omission of many of the most eminent modern etchers altogether—except ignorance, carelessness, or prejudice. The man who influenced modern French etching more than any other was Maxime Lalanne, and his name is never mentioned. Nor are the names of Louis Legrand—the most brilliant etcher in France to-day — nor Paul Renouard, or J. L. Forain; and, in colour, Raffaelli, who has taught people in this country all they have not understood, nor Marie Cassatt, who does understand how to manage it.

The man who to-day is recognised as the greatest etcher in his own country—and this verdict is repeated everywhere else—Bauer, is not referred to, nor Van s'Gravesande either. In Belgium, Rops is omitted as well as Baertoen. In England, I fail to find the names of Sir Charles Holroyd and F. E. Spence in pure etching, Laurenson in colour, and where is Mr. Augustus E. John? Duveneck might as well never have lived if we depended on Mr. Wedmore, and there are at least three other Americans who should be mentioned if MacLaughlin is—C. Harry White, H. Webster, and C. A. Platt. The omission of my own name I can endure with equanimity, for that was not due to ignorance. The only claim that Mr. Wedmore may possess—as authority—that I am aware of, is as the compiler of a catalogue of Whistler's etchings, completely superseded—in the opinion of everyone who knows save himself—by those of Howard Mansfield and the Grolier Club. He, however, still believes in it, and refers to it in his article on Whistler in the new edition of the "Encyclopædia Britannica" and ignores the others. I looked his article up the other day and found in it a round dozen appalling blunders. Reproductive etching is beneath his notice, and therefore the work of William Hole, Unger, and Waltner.

JOSEPH PENNELL.

3, Adelphi Terrace House, Robert Street,
Strand, London, W.C.,
August 12th, 1911.

NOTES ON BOOKS.

IMPERIAL TELEGRAPHIC COMMUNICATION. By Charles Bright, F.R.S.E., M.Inst.C.E., M.I.E.E. London: P. S. King & Son. 3*s*. 6*d*. net.

This volume consists for the most part of reproductions of various papers, addresses and articles contributed during the past ten or eleven years to the British Association, the London Chamber of Commerce, and several of the leading reviews; and the immediate occasion for their republication was the recent Imperial Conference. The subject is one of very great importance, both from the commercial and the strategic points of view; and probably no one is better qualified to speak upon it than Mr. Bright, whose interest in it may be said to be hereditary, for it was his father, Sir Charles Tilston Bright, who laid the first Atlantic cable in 1858.

Throughout these pages Mr. Bright has two principal objects in view: to secure a reduction of the rates for cablegrams and to establish all-British telegraphic communication throughout the Empire. The first was one of the points considered by the Cable Communications Committee of 1901, and their suggestion to establish a system of deferred rates is the only one of their recommendations which has up to the present been acted upon. But an appendix to this volume containing a table of charges for foreign and colonial telegrams shows how extraordinarily costly it is to cable to some parts of the world, and to some parts of the British Empire: *e.g.*, the rate to British Guiana is 7*s*. a word. A rate such as this must be practically prohibitive, for, of course, as Mr. Bright remarks, when the tariff is high the traffic is correspondingly low. The defects of the telegraphic systems in the West Indies were thoroughly discussed by the Royal Commission on Trade Relations between Canada and the West Indies, and they were so striking that in their report the Commission recommended a policy of Government expropriation.

While it is not easy to over-estimate the value of reasonable tariffs, not only for commercial purposes but for binding the distant parts of the world together by the rapid dissemination of news, etc., the strategic importance of the cable to an Empire scattered all over the face of the world is even more vital. At present our cables to the Cape touch on foreign territory at more than one point, and even the all-British Pacific cable has to depend on the Atlantic Cable Companies for the transmission of messages between Canada and this country. The necessity of being able to keep our communications with India untapped by any foreign Power must be obvious to everyone.

While Mr. Bright would be content to leave international cables in the hands of private companies, he is strongly of opinion that strategic lines, at all events, come within legitimate Government scope, and he advocates the establishment of a new board of control, or authority, to deal with these

matters. The Colonial Office, which might be supposed to be primarily interested in the question is, in his opinion, too much "over-ruled by the department with the purse-strings on the one hand; and, on the other, by a technical department which has practically nothing to do with our over-sea dominions or with the technique or administration of *ocean* telegraphy."

With regard to the form of the volume, objection may be raised on the ground that as the various papers composing it have been written at intervals spread over eleven years, and as there have been considerable developments in telegraphy during that period, it is necessary, when reading each article, to bear in mind continually the exact date at which it first appeared. There are, doubtless, some drawbacks in this, and Mr. Bright has evidently been conscious of them himself, for he has made a statement in a preface of the most important developments which have taken place since the dates of the various articles. But, regarded historically, this arrangement has its advantage, for it enables one to follow from contemporary documents the exact history of the industry. In any case the book is extremely interesting, and it deserves the careful study of business men, statesmen, and strategists.

Office Procedure and Business Correspondence. By H. Clemson. London: Butterworth & Co. 2*s*. net.

Methods and Machinery of Business. (Second Edition.) By H. Clemson. London: Butterworth & Co. 2*s*. 6*d*. net.

These two volumes are designed as handbooks for students preparing to enter for commercial examinations. The former is of an elementary nature; the first seventeen chapters are devoted to letters, messages, goods, and simple accounts, and are recommended as a first-year course in schools where much time cannot be given to commercial work. The second part deals with bills of exchange, security, international commerce, partnerships, companies, etc., and is adapted to a second-year course. The volume contains an article on Life Insurance, by Mr. J. Burn, and another on Railways, by Mr. W. Brazier Martin.

"The Methods and Machinery of Business," which has reached its second edition, is of a more advanced nature, and is intended more especially for clerks in shipping departments and students entering for higher commercial examinations. It is divided under four main headings: inland and foreign exchange, marine insurance, fire and life insurance, and stock exchange. The author has added a fresh chapter, in which he reviews the various causes of the fluctuations in the market price of Consols, and criticises the suggestions recently put forward with the object of raising their price.

Mr. Clemson has had considerable experience as a teacher of commercial subjects. He writes in a clear and simple style, and the illustrations which he has introduced of bills of lading, bills of exchange, invoices, contract notes, broker's tickets, etc., should be useful in familiarising the young clerk with documents of this description.

GENERAL NOTES.

The Foreign Trade of France.—The total value of the exports and imports of France during the first six months of the present year, notwithstanding that they show an increase of 771,386,000 francs (£30,863,440) over that of the corresponding period last year, is not by any means as satisfactory as it may appear at first sight. From the following figures it will be seen that, whilst the value of the imports show an increase of 843,174,000 francs (£33,726,960) during the first half of this year, that of the exports has fallen off by 71,588,000 francs (£28,635,200):—

	Value of Exports (in 1,000 francs). 1910.	1911.	Difference in + or −
Food stuffs	431,113	334,931	−96,182
Raw materials	969,702	951,478	−18,224
Manufactured goods	1,451,251	1,497,980	+46,729
Postal parcels	244,634	240,733	− 3,901
	3,096,710	3,025,122	−71,578

	Value of Imports (in 1,000 francs). 1910.	1911.	Increase.
Food stuffs	563,123	1,141,125	578,002
Raw material	2,304,219	2,518,702	214,483
Manufactured goods	700,976	751,665	50,689
	3,568,318	4,411,492	843,174

This falling off is particularly noticeable in the enormous increase in the value of the food stuffs which it has been found necessary to purchase abroad, in order to make up the deficiency caused by last year's bad harvest.

Anchovy Fishery at Cannes.—The anchovy fishery on the French Riviera has been, on the whole, very successful during the past season, the catch generally being above the average. According to the returns of the inspector of fisheries on this coast, the quantity of this fish sent by rail from Cannes during the month of June last amounted to 175 metrical tons, as compared with 170 metrical tons during the corresponding period last year. The fish is salted and packed at the various establishments for the purpose in the neighbourhood, and especially at Cros-de-Cagnes, from which place sixty-five tons were exported to Germany, this being the first time that anchovies have been sent from the Cannes district to that country. The prices obtained this season have been higher than usual, and have reached 75 centimes per kilog. (about 3½*d*. per lb.), as compared with 50 cents. per kilog. (about 2¼*d*. per lb.) in 1911.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

CANTOR LECTURES ON "THE APPLICATIONS OF ELECTRIC HEATING."

The Cantor Lectures on "The Applications of Electric Heating," by Professor J. A. Fleming, M.A., D.Sc., F.R.S., have been reprinted from the *Journal*, and the pamphlet (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.

A full list of the Cantor Lectures, which have been published separately, and are still on sale, can also be obtained on application.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

BREWING AND MODERN SCIENCE.

By Professor ADRIAN J. BROWN, F.R.S.

Lecture I.—Delivered February 6th, 1911.

INTRODUCTION.

The last course of Cantor lectures on the subject of the brewer's art dates as far back as the year 1873. Towards the close of that year my distinguished predecessor, Dr. Charles Graham, commenced a course of seven lectures "On the Chemistry of Brewing," which most deservedly attracted the attention of the brewers of this country. The period when these lectures were given marked the commencement of a new era in the history of the brewing industry, for it was at a time when the growth of scientific knowledge had reached the stage at which it first gave promise of illuminating some of the complex problems of the brewer. The progress of science from the beginning of the century had been extraordinary, and many of our arts and manufactures had benefited widely from its advance long before brewing shared in its benefits. It was not until the value of Louis Pasteur's epoch-making discoveries in fermentation began to be recognised about the year 1870, and the results of O'Sullivan's earlier investigations of starch transformation became known in 1872, that science was in a position to contribute material assistance to the art of brewing. Thus it came about that Dr. Graham, through his well-known course of Cantor lectures in 1873, was enabled to proclaim to the brewers of this country that science was making advances which should prove useful to their industry. Undoubtedly other chemists than Graham, such as O'Sullivan and Horace Brown, had previously turned their attention in the same direction, with the consequence that the more recent advances of science had already been recognised and utilised in some few breweries of the country, but it must ever remain as an honour to the memory of Dr. Graham that his lectures first directed the attention of brewers at large to a serious consideration of the scientific aspect of their industry.

Thirty-seven years after the delivery of Dr. Graham's memorable course of lectures, I have been asked again to review the position of science with regard to brewing. I approach the task with diffidence, feeling that it might with advantage have been placed in much abler hands. In one respect only can I claim to possess any good qualification for the task; it happens that the date of Dr. Graham's first lecture coincides almost exactly with the date of my introduction to practical brewing, and my first unassisted mashing operation was conducted when Graham's course of lectures was in progress. As I have continued to be intimately associated both with the technical and the scientific sides of brewing ever since, I may claim that I have at least been granted an opportunity of watching the progress of brewing and of the sciences bearing on it from the date of Dr. Graham's lectures until the present time.

In one respect, at least, Dr. Graham's task was less difficult than mine, inasmuch as he had the opportunity of expounding his views of a comparatively undeveloped subject in seven lectures; whilst the exigencies of present rapid life allow me only four lectures in which to treat the same subject grown to gigantic size. At the time Dr. Graham gave his course of lectures, his subject was not only a restricted one, but it also was quite new, and he was favoured with an audience eagerly awaiting enlightenment in the very elements of science relating to their industry. To-day things are greatly changed—scientific knowledge has increased to vast proportions, and brewers may justly claim that no industry in this country can exhibit a better record of the recognition and use of this knowledge than theirs. The leaders of many of our industries are often charged with ignoring or overlooking the benefits which science is able to confer; but however true this may be of some industries, it is not so with brewing. Almost every brewer to-day avails himself to some extent of the assistance of science, and but rarely does he refuse to listen to anything science may have to suggest for his possible benefit. No doubt, as a shrewd man of business, he is inclined at times to ask disconcerting questions of the apostles of science with regard to the limitations of their knowledge—but, whatever he may say, the conduct of his business supplies ample evidence that scientific truths, when properly substantiated, are valued by him and made use of. The brewer of the present day not only makes use of science, but is himself often well versed in science as it relates to brewing. To-day he commands useful books on the subject—his technical journals specially devote themselves to keeping him posted in all the more recent advances in the subject—and he possesses an institute devoted to furthering its progress. Thus conditions have changed very much since Dr. Graham gave his course of lectures in 1873, both with regard to the development of the subject, and to the manner in which it is desirable to lay it before an audience. I feel that the time has gone by for any good object to be served by lectures on the elements of science in relation to brewing of a similar type to those given by Dr. Graham, for it would be telling an old tale to the majority here present; on the other hand, when considering how to treat my subject to the best advantage, I am met by the very great difficulty that, owing to its vast extent, it is impossible to deal comprehensively with it even in a much longer time than I have at my disposal. Under these conditions, in order to meet the difficulty to the best of my ability, I propose to select a few representative branches of my subject which possess special interest, and endeavour to show how our knowledge of them has progressed from Graham's time until now, and in what direction scientific investigation is at present leading in connection with them.

But doubtless there may be some in this room, not very familiar with the technical or the scientific aspects of brewing, who may find some difficulty in realising the complex nature of the problems which meet the brewer when he attempts to master the inner working of his processes. A brief glance at the general methods of brewing procedure will, however, demonstrate how the processes are a sequence of bio-chemical changes of the most complex character.

The brewer's objective is to prepare a fermented beverage from barley or other starch-containing grain. His processes, no doubt, originated in ages past through the desire to imitate the production of wine in lands where the grape was not found. The making of wine from the grape is a very simple technical process—the juice of the fruit provides the sugar-containing fermentable liquid, and the skins of the fruit supply the yeast capable of fermenting the sugar: thus crushing the fruit and leaving the crushed mass to stand, results in the production of wine. But it is only by the means of methods involving many complex bio-chemical changes that the brewer can obtain a fermentable liquid from the insoluble starch of grain.

Having selected some grain, such as barley, suitable for his malting process, he proceeds to steep it in water in his cistern in order that the life of the seed, which is dormant in the germ when in the dry state, may be summoned into activity. Then he spreads his moist grain on the floor of the malt-house at a suitable temperature for germination, and awaits the vital processes which ensue as the embryo plant which is contained in each seed commences to develop. Now we must imagine the complex bio-chemical actions which proceed as germination takes place. The germ of the corn gains energy by respiration, absorbing oxygen from the air and utilising it for the combustion of a small portion of the carbohydrate or starchy material with which the corn is so well stored. At the same time, complex digestive changes commence in the corn through the intervention

of enzymes, such as diastase, which are produced during germination for the purpose of dissolving the starch and other constituents of the grain, converting them into suitable food for the growing germ. On the malting floor, as the barley germinates, we are, therefore, witnessing a series of bio-chemical changes of extreme complexity, many of which most intimately concern the purposes of the brewer. But growth of the grain on the malting floor must be allowed to proceed only to a limited extent, otherwise too much of the contained starch from which the brewer ultimately obtains his fermentable sugar will be digested and used as food by the growing germ. Hence, after the grain has grown for a limited time on the malting floor, it is taken to the malt-kiln, where it is dried and "cured" in a current of hot air, in order that its growth may be completely arrested.

As the malt, after being dried in this manner, contains starch together with the digestive enzyme diastase, the starch of the malt is in a potential condition for conversion into fermentable sugar when placed under suitable conditions. These conditions are fulfilled in the subsequent mashing process of the brewer. In this process the previously crushed malt is mixed or "mashed" with water at a temperature of about 65° C. (149° F.), when conversion of the starch into sugar—which would have taken place within the corn if germination had not been restricted by drying on the malt-kiln—now takes place in the mash-tun. Therefore, the complex action of starch transformation during the mashing process, although it proceeds at a temperature inimical to life, may be classed as the continuation of a bio-chemical action.

The solution of sugar and other materials derived from the malt, termed by the brewer "sweet wort," after being run from the mash-tun, is then transferred to a vessel in which it is boiled together with hops. Boiling is necessary for the purpose of coagulating and removing from solution the diastase and certain other protein constituents present in the sweet wort, and also in order to sterilise completely the liquid. Hops are boiled with the wort mainly for two reasons—the agreeable bitter flavour conferred on the beer by their use, and for the purpose of extracting certain constituents possessing preservative power which tend to keep the resulting beer sound.

The boiled wort, after leaving the brewing copper, is subsequently cooled to a suitable temperature of about 15° C. (59° F.), and is then run into so-called fermenting vessels. Here active yeast from a previous brewing is introduced, and the wort commences its primary fermentation, which eventually converts it into beer. This process again introduces us to bio-chemical actions of a most remarkable and important character. During fermentation we have to deal not only with the decomposition, or fermentation, of the sugars present in the wort by the action of the enzymes existing in the living yeast cells, but we have also to deal with the increase or multiplication of the yeast cells and the influence of this on the removal of nitrogenous material from the beer, a matter of fundamental importance in brewing.

In technical practice there are several different ways in which the primary fermentation of the brewer is conducted, but in principle they are all the same and involve fermentation by the addition of yeast and subsequent removal of the increased yeast crop from the final beer. But termination of primary fermentation by no means closes the bio-chemical history of beer. At the conclusion of primary fermentation beer is a flat, lifeless liquid, not the sparkling beverage charged with carbonic acid gas ordinarily recognised as beer. In order to obtain such, it is necessary for a slow secondary fermentation to take place in the beer when it is in cask or bottle, in order to produce the "condition," or sparkling gaseous state which is required. This change again introduces us to biological problems of the utmost importance which are concerned with the development of secondary yeast-growths in beer, about which at present there is still much difference of opinion.

However, I think I have said enough now to demonstrate even to those but slightly acquainted with the bearings of scientific knowledge in relation to brewing, that the study of the science of brewing is essentially a biological study, and that, like all studies which concern the functions of life, it therefore presents problems of extreme complexity.

Barley.

In the past, no doubt, the brewer—more particularly when he was not his own maltster—was too apt to regard malt as the primary basis of his manufacture, and was inclined to overlook many important questions concerning the barley from which his malt was made. But to-day, I believe, every brewer recognises to what a vast extent his welfare depends on the quantity and quality of the barley supply—and, recognising this, he

has also begun to recognise that his interests and those of the agriculturist, the producer of the barley, are most intimately bound together. But this fact has been, and is still—I regret to say—far too often overlooked by the agriculturist, with the result that the great industries of agriculture and brewing are estranged in a manner which is altogether undesirable. I fear, although I may be accused of undue bias, that the agriculturist must be regarded as primarily responsible for this, for when considering his present position with regard to brewing he overlooks certain very evident facts, and imagines things of the brewer which have no reality. In the past, under different economic conditions and under very different excise laws, the agriculturist was accustomed to regard the brewer as an ever-ready purchaser of his malting barleys at prices of a highly remunerative character; at present, under altered conditions of business and under altered excise laws, he finds the brewer a less ready buyer at reduced prices; and the brewer is held to blame by the agriculturist for this result, and not the altered conditions which have been forced upon the brewer much against his will. The agriculturist appears to overlook altogether the fact that the crude and wasteful methods of brewing employed in the past are not possible now under present altered requirements, and under the heavy load of taxation which brewing is now compelled to bear; brewing as an industry must have ceased to exist years ago unless its methods had been accommodated to altered conditions. Increased knowledge has enabled the brewer to obtain better extracts from his malts than were obtainable years ago; it has taught him how to make use of barleys which could not be malted with advantage under the incidence of the old malt-tax; lighter gravity beers, requiring less malt for their production, are brewed now to meet the public taste, and no doubt also to some extent—but one usually much over-estimated—other grain than barley is employed in brewing under sanction of the Inland Revenue Act of 1880. All these conditions may have tended to diminish the consumption of home-grown barley, or to lower its market value to some slight extent, but they are entirely beyond the brewer's control. They have been forced upon him against his wish, and at a time, too, when the general public demand a better, a brighter, and a more stable beer than they were accustomed to years ago. I consider that the brewers of this country have every reason to be proud of the achievement of producing sounder, better, and more wholesome beer for the public use during a period when their industry has had to struggle against the effects of repeated increases of taxation. The task has been rendered possible only by an intelligent use of science — and the generous reward for enlightened progress has been further invitations of a pressing character to contribute more to the public exchequer, and a free circulation of the baseless accusation that improved methods of beer production are obtained by unfair means. I do not regard agriculturists as the authors of this accusation, but perhaps some of them are too ready to believe it, because it may appear to further their efforts in the impossible direction of putting back brewing into the place it occupied years ago. Concerning the accusation itself, I need only point out that breweries are under the inspection of Inland Revenue officials night and day, and that it is the duty of these officials to take account of all the materials the brewer uses, and to supervise all his processes. What other manufactured alimentary product than beer possesses a guarantee of purity such as this? It is unjust for the agriculturist to cast blame on the brewer for any depreciation in the value of his home-grown barley, and it is hopeless to attempt to bring back the past. The interests of the agriculturist and the brewer must always remain most closely associated, and if only this were better recognised much might be achieved for their mutual benefit. In Denmark we have an instance of practical good achieved through a systematic study of barley from the combined points of view of agriculture and brewing. In Ireland we find another instance. Why should we not have something similar in this country in the place of misconception and hard words, which in themselves are not only useless but actually harmful? If, in the brief sketch I propose to give of the progress of our knowledge of malting barley from Dr. Graham's time to the present, I should say anything which tends to bring the interests of agriculture and brewing together ever so little, I shall indeed feel very pleased.

Thirty-seven years ago, when Dr. Graham delivered his course of lectures, our knowledge of the various kinds of cultivated barley was very limited. The different types of barley had been classified by botanists and, of course, agriculturists and maltsters were in possession of a very considerable amount of empirical knowledge concerning them, but no one up to that time

appears to have made any serious attempt to study them scientifically. Apart from the fact that knowledge, perhaps, was hardly ripe for this, there was not the inducement then, as now, to take a wide interest in barley. Before the abolition of the malt-tax in 1880, the number of different kinds of barley which could be used by the maltster with advantage was comparatively small, owing to the fiscal conditions under which the maltster worked. After these conditions were changed in 1880, the maltster was enabled to malt any class of barley suitable for brewing purposes, and, as a consequence, the demand for a more extended knowledge of barley arose.

Almost the only reference to barley in relation to malting in Dr. Graham's lectures is contained in the single remark that it should be grown on a light soil and should contain a large amount of starch. This must not be taken as accurately defining the knowledge of the time, but such a very brief reference to barley in a comprehensive course of lectures on brewing indicates that the subject was not regarded by brewers of the day as one of great importance.

The first distinct advance in our modern knowledge of barley may be traced to Körnicke, of the Academy of Agriculture of Poppelsdorf, who published a monograph on barley in 1882. This was followed in 1885 by the publication, in conjunction with Werner, of a still more comprehensive work, in which all the then known varieties of barley were described, together with the results obtained when cultivating them on the experimental plots of the Academy. But Körnicke's work was carried out and described in Germany, and little or nothing was known of it in this country outside the circle of professional botanists, until it was brought into general notice by E. S. Beaven, of Warminster. So far as this country is concerned, Beaven is unquestionably entitled to be called the father of our modern knowledge of barley; it is his work, his publications, and his enthusiastic support of any inquiry relating to barley, that have mainly contributed to the recent advance in our knowledge of the subject.

Beaven's first important communication on barley was made in a paper written in conjunction with Munro, and published in the *Journal of the Royal Agricultural Society* in 1900. In this paper the different types of barley cultivated in England are described, and it also contains an account of the results obtained when growing a number of different types of barley on experimental plots at Warminster. But it is to Beaven's well-known paper on "Varieties of Barley," published in the *Journal of the Institute of Brewing* in 1902, that we must look for a work which has become a standard for all agriculturists, brewers and others in this country who are interested in malting barley.

Beaven's paper is divided into two sections—in the one he classifies and describes all the known types and varieties of barley, and in the other he discusses them from the maltster's point of view. A very brief summary of this paper, although so well known, will not perhaps be out of place here as an aid in demonstrating the position we now occupy with regard to our knowledge of barley.

Beaven adopted, in the main, Körnicke's system of classification of barley, which is

A. B.

FIG. 1.—TWO-ROWED BARLEY.

A. Broad-eared barley (*Hordeum zeocriton*) with short jointed rachis.

B. Narrow-eared barley (*H. distichum*) with long jointed rachis.

simple and easily understood. It is based on the position and character of the flowers of the barley plant which produce the seed.

The flowers are situated, as is well known, on the stem of the ear of barley termed the rachis. If we examine the rachis of an ear of common barley from which the corns have been removed, we find that it is a flattened stem with joints on each side of it placed not opposite to each other, but alternately. Now the flowers of the barley plants spring from these joints, and the slide shown on the screen represents the appearance of the flowers springing from a single joint of an ordinary two-rowed barley. They are three

in number, as is the case with all the forms of barley with which we are concerned, but the central flower is much larger than the two side flowers. If we could examine the constitution

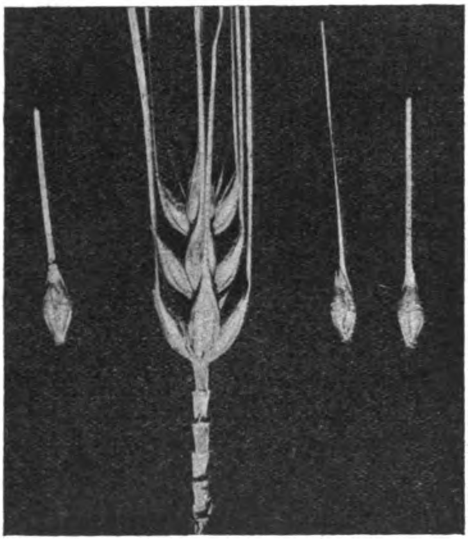

FIG. 2.—SIX-ROWED BARLEY (*H. vulgare*).

of these flowers more closely, we should find in the present instance that the central flower is the only one which is fully developed and possesses an ovary capable of forming a seed—the two outer flowers are merely abortive ones. Consequently, after fertilisation and seed development, a single row of corns only would be found on each side of the rachis of this type of barley, and in this manner what is ordinarily known as a two-rowed barley is constituted (see Fig. 1). But, on the other hand, there is a type of barley in which we find that all three of the flowers on each joint of the rachis are fully developed and each capable of forming a seed (see Fig. 2). Under these conditions, after fertilisation and seed development, we find three rows of corns on each side of the rachis, and this constitutes what is known as a six-rowed barley.

From the position and character of the flowers of different types of barley we are therefore enabled to classify them all into two broad groups, viz., six-rowed barleys, and two-rowed.

To make a further advance in the classification of the different kinds of barley, the shape of the heads of both six- and two-rowed barleys must be taken into account. These may be short and broad, or narrow and long. The long, narrow heads are occasioned by the joints of the rachis from which the corns spring being placed widely apart — in the broad-headed barleys the joints are much closer together (see Fig. 1).

Thus, by grouping barleys in the first place into six-rowed and two-rowed forms by the very simple means of flower arrangement already described, and, secondly, by dividing the six-rowed and two-rowed groups into narrow-eared and broad-eared divisions, we are enabled to place all the different varieties of barley of interest to the brewer in four distinct classes :—

I.

Six-rowed Barley.

Wide-eared, with short joints (*H. hexastichum*).
Narrow-eared, with long joints (*H. vulgare*).

II.

Two-rowed Barley.

Wide-eared, with short joints (*H. zeocriton*, Goldthorpe).
Narrow-eared, with long joints (*H. distichum*, Chevalier).

This classification comprehends all the kinds of barleys which are suitable for malting. There are two uncommon species not employed in malting which do not come under its arrangement, but they may be left out of consideration now.

Having classified all types of malting barley into four main sub-species, Beaven showed how

B. *A.*

FIG. 3.—SIX-ROWED BARLEY.

A. Wide-eared, with short joints (*H. hexastichum*).
B. Narrow-eared, with long joints (*H. vulgare*).

each of these four sub-species may be further divided into numerous varieties recognisable by such characteristics as their colour, the character of the outer skin or husk, the nature

of the basal bristle, and other points of distinction which I need not go into now.

The system of classification just described has been generally accepted in this country, and directly and indirectly it has assisted very materially in advancing our knowledge of malting barley. Another system of classification proposed by Atterberg, a Swede, in 1905, has more recently attracted considerable attention. Like the Körnicke-Beaven system, it possesses the merit of simplicity, and has, perhaps, in certain respects some advantages over the former, but, taken as a whole, these advantages hardly justify the risk of creating complications which are apt to ensue when a well recognised system of classification is replaced by a new one. The main use of any system of classification is

B. A.

FIG. 4.—TWO-ROWED BARLEY.

A. Wide-eared, with short joints (*H. zeocriton*, Goldthorpe).

B. Narrow-eared, with long joints (*H. distichum*, Chevalier).

to assist in indexing and grouping individuals for the purpose of easy recognition, and this appears to be sufficiently well effected by the Körnicke-Beaven system.

The second part of Beaven's valuable paper is devoted to a discussion of certain technical questions of great importance which are associated with the malting value of barley.

The present mode of barley valuation for malting purposes, notwithstanding the advance of scientific knowledge, is still based on the same empirical methods which have been in use for years past. Practically, the whole of the world's supply of malting barley is bought and sold under the rule of empiricism, and scientific method has little or nothing to do with it at present. Now the object of much of Beaven's work has been to trace the connection between the empirical characteristics which are believed to denote malting quality in barley, and their underlying causes ascertained by scientific investigations, and to endeavour to discover if the one is supported by the other. The quality of barley for malting purposes is determined technically by such characteristics as the character of the skin of the grain, its size and shape, its colour, and the relative hardness of its endosperm, together with other characteristics which are comprehended under the term "maturation." How are these characteristics, which are supposed to indicate "quality" of barley from a malting point of view, supported by scientific investigation?

For instance, a thick coarse outer skin, according to empirical testing, characterises poor malting quality in a barley; a thin skin indicates good quality. Why are the contents of the barley corn, in which its malting value lies, correlated with the nature of the skin of the corn? Beaven shows that the energy of every seed-bearing plant, tends in two directions—vegetation, or the actual growth of the individual plant, and seed production, the effort of the plant towards reproduction. These two phases of life are not of necessity equally represented in the same individual plant—in fact it is common knowledge that very luxuriant growth is often detrimental to the free production of flowers and seeds. Now the husk, or thick skin of the barley corn is no part of the true seed, it is merely the withered remains of two leaves of the barley plant which originally enclosed the flower, and which continue to adhere to the true seed when it is ripe. So the husk of the barley corn reflects the character of the vegetative growth of the plant which bore it. What then must we expect of the character of the seed of a coarse and so-called thick-skinned barley? Such a skin is the result of luxuriant vegetation, and Beaven's experiments show that the seed borne by plants of luxuriant growth, induced, maybe, by over-manuring, thin planting, or heavy soil, almost always lacks the quality of good malting barley. It is usually hard, contains excessive amounts of nitrogenous matter, and is deficient in starch. Too luxuriant a growth of the plant does not go with the production of good seed—hence one of the ordinary methods of the valuation of malting

barley by external appearance is upheld by scientific investigation. I may further add that this conclusion has been very amply confirmed more recently by investigations carried out in the Guinness Research Laboratory and described in the *Transactions* of that Laboratory.

The "maturation" of barley as an indication of malting quality is another most important question to which Beaven has devoted a very considerable amount of attention. The quality of maturation, which may be defined as the complete development and ripening of the seed, comprehends almost all the characteristics denoting malting quality in barley, and its importance can hardly be over-exaggerated. In fact, Beaven maintains, with regard to the valuation of barley for malting purposes, that more importance may be assigned to the proper maturation or ripening of the sample than to the particular variety of barley from which the sample has been grown. He does not, of course, overlook the great differences in malting value which exist between the various varieties or species of barley, but considers that even these are less important than maturation, and I am inclined to think that there are very few technologists who will disagree with this view.

The character of maturation is usually judged from the external appearance of the grain. Beaven, however, points out how other data may assist in recording this important quality These data are:—

1. The mellowness of the grain, indicated by its whiteness when cut through.
2. The specific gravity of the grain.
3. The relative starch and nitrogen content of the grain.
4. The character of its nitrogenous matter.

All these data are shown to be interdependent to a greater or less extent. For instance, mellowness or "mealiness" of the grain, that very desirable characteristic for a malting barley, has been shown to be accompanied by air spaces within the starchy mass of the endosperm of the grain; in fact, the white mealy appearance of a mellow corn is occasioned by the presence of numerous small fissures ramifying through this starch-containing part. Consequently a tender grain of barley has a less specific gravity than a steely grain, because it contains numerous air-filled, or possibly vacuous spaces.

Again, steely barley generally possesses a high nitrogenous content, and, being steely, its specific gravity is comparatively high.

High nitrogen content is also intimately associated with the relative amount of starch present in the grain. Barley may contain from 8 to 12, or even more, per cent. of nitrogenous matter, and excess of this matter displaces to a greater or lesser extent the soluble starchy matter of the grain; as a consequence, with a barley of high nitrogenous content there is a loss of extract, for the greater part of the nitrogenous matter which displaces the starch is not capable of yielding available extract.

The relation of the character of the nitrogenous matter of the grain to the data regarding mellowness, specific gravity, and relative starch and nitrogenous content, is less well marked. Beaven shows, however, that by employing 58 per cent. alcohol as a solvent for the barley proteins, certain of the proteins soluble in this solvent are markedly less in amount in steely barleys than in mellow ones, and thus he knits together to some extent the character of the nitrogen constituents of barley with the other characteristics determining maturation.

I regret that it is impossible to refer now, even briefly, to many other important points discussed by Beaven in his attempt to harmonise the more scientific aspect of maturation with that of technical experience. The influence which his work in this direction has exerted in advancing our knowledge of the character of barley suitable for malting purposes is very great indeed.

I must now pass on to consider some of the conclusions arrived at by Beaven when studying certain sub-species and varieties of barley from the agricultural and malting points of view.

The six-rowed barleys, which are so important as malting material, are obtained almost entirely from countries possessing a warmer and more sunny climate than our own and, from the point of view of home agriculture, there is but little to be said at present about them. It is well to bear in mind, however, that experience has shown in recent years that good malting barley of six-rowed type can be grown in this country as a remunerative crop. Some six-rowed barleys are remarkably heavy croppers, and possess characteristics of considerable value. Hybrid six-rowed barleys have been produced which are promising, and marked improvement in the general character of six-rowed barleys has also been obtained by judicious selection. There is, no doubt, a considerable amount of prejudice in this country against six-rowed barley culture, and much of this is well justified; but

it is desirable to bear in mind for the good of both agriculture and brewing that conditions no doubt exist under which the growing of a suitable variety of six-rowed barley may yield very remunerative crops. Such conditions are found both in Belgium and the north of France.

Two-rowed barleys are the special consideration of the agriculturist in this country, and probably will always remain so. As we have seen, there are two distinct classes or sub-species of two-rowed barley in cultivation—the long narrow-eared kind often styled "Chevalier," and the short wide-eared kind, usually called "Goldthorpe" (Fig. 4). Now, about the respective merits of these two kinds of barley very wide differences of opinion exist, more especially with regard to their malting and brewing value.

Thirty-seven years ago, when Dr. Graham lectured, broad-eared barleys were comparatively little grown, but since that time their culture as Goldthorpe, or as hybrids such as Standwell and Invincible, has gradually spread until, in some parts of the country, they appear to be displacing the narrow-eared Chevalier type altogether. Some brewers, who find broad-eared barleys supply material suitable to their need, contemplate this with equanimity; others, probably in the majority, regard the change with great disfavour, for they maintain that the best qualities of beer can only be obtained by the use of malts made from narrow-eared Chevalier barleys. Beaven has much to say in connection with this subject from the point of view of the relative malting value of Goldthorpe and Chevalier barley, but, important as it is to settle the question of malting value, this does not of necessity settle the question from the brewers' point of view—the brewery must be the ultimate court of appeal. Granting for the moment that malts in every respect of equal value, according to our malt standards, can be made from Goldthorpe and Chevalier barley, it does not follow that the results they yield in the brewery will be equally satisfactory. Evidence with regard to this question is very conflicting. Making every allowance for prejudice in one direction and another, practical results indicate that, in some breweries at least, Goldthorpe malts prove inferior to Chevalier for brewing the highest qualities of ale. Very possibly the true cause for a difference of opinion on this question originates in the varying requirements of different breweries. These requirements vary to a very great extent, and may well determine the difference of opinion held on this subject. At present the relative merits of Goldthorpe and Chevalier barley as brewing material remain in dispute, with the weight of evidence tending in favour of Chevalier for the production of the higher qualities of ale.

Apart from the relative brewing qualities of Goldthorpe and Chevalier barley, Beaven's work on their relative malting value is of importance. Goldthorpe barley, contrary to what is often believed, is, according to Beaven, not a more highly nitrogenous barley than Chevalier—in this respect the two barleys are very similar. Neither does Goldthorpe appear to be a less "free-working" barley than Chevalier, when malting conditions are strictly parallel. Its extract-yielding capacity is, on the whole, somewhat larger than Chevalier, and if, in certain respects, it must be placed a little lower than some kinds of Chevalier, on the other hand it is superior to other kinds. In fact, to quote Beaven's own words, his results "prove that sweeping condemnations of Goldthorpe are not warranted," but he also adds, "they prove nothing more." This was the position when Beaven read his paper in 1902, and at the present time there appears to have been no further advance towards a more definite understanding of the subject in this country. It is one that is left for the future to decide, and is certainly one that deserves the special attention of both brewers and agriculturists here, if, as some suppose, there is a prospect of the cultivation of Goldthorpe further displacing that of Chevalier.

There is much need in this country for further knowledge of these and other kindred subjects associated with barley. A good deal has already been done in the direction of hybridising barley and producing new species suitable for malting purposes. Messrs. Garton have been the leaders in this, and Professor Biffen of Cambridge has also taken up the subject, and, following Mendelian methods, appears to be obtaining most valuable results. Beaven is also conducting experiments in the same direction. Experiments have also been carried on at various agricultural centres, notably at the Agricultural station of the University of Leeds, on the influence of different manures on the yield and quality of barley, which have added considerably to our knowledge of these subjects. But no thoroughly systematic investigation of barley both from the agricultural and the malting point of view has

been attempted in this country such as the one which has been carried out by the Danish Department of Agriculture with so much success. No one, of course, looks for assistance from our English Department of Agriculture in any practical investigation of this kind, so it comes with additional pleasure to find that the Irish Department of Agriculture has, during recent years, actively participated in a prolonged and systematic investigation in connection with malting barley, the results of which are of very great interest. As the results of this investigation are but little known in this country, and as they undoubtedly represent the most recent advance in knowledge regarding the cultivation of malting barley, it appears very desirable to refer to them here.* It is true the object of the investigation was to study the requirements of barley cultivation in Ireland, a country where agricultural conditions differ materially from those obtaining here, but nevertheless it will be found that the knowledge gained possesses much interest for us in England.

A few words may perhaps be said with advantage regarding the admirable system adopted in the Irish investigation. The first and main object was to ascertain, in the interest of Irish agriculture, what kind of malting barley was the most profitable for the farmer to grow. Other important points in connection with the influence of manuring on yield and malting quality, time of sowing, climatic conditions during growth and harvesting, etc., also formed part of the investigation, but these points were in a manner subordinate to the main object already mentioned.

The leading experiments, which were commenced in 1901 under the supervision of the Irish Department of Agriculture, were supported very materially by Messrs. Guinness, of Dublin, who not only contributed largely towards the necessary expenses, but also employed the extensive technical and scientific resources they have at their command to assist the investigation. Under these circumstances the experiments were carried on under especially favourable conditions for obtaining valuable practical results.

The experiments were conducted on farms distributed throughout the barley-growing districts of Ireland, and were continued during a period of six successive years. In this way complicating factors associated with soil, district, and varying weather conditions were to a large extent eliminated during the investigations. The various kinds of barley cultivated were grown on two-acre plots, areas sufficiently large, not only to yield thoroughly representative crops for technical valuation, but also quantities of grain large enough to be malted in the experimental malthouse of Messrs. Guinness.

The kinds of barley examined comprised both narrow-eared and broad-eared types. The narrow-eared barleys included the varieties known as Archer, Scotch Chevalier, Hallett's Chevalier, Old Irish and Danish Archer. The broad-eared barleys included Goldthorpe and Standwell, the latter a very well-known hybrid reproducing Goldthorpe characteristics.

The most important object of the investigation was to determine the yield and money value of the different varieties tested. The yield was obtained, after careful supervision during harvesting, by weighing the grain after threshing; from the result, the yield per statute acre was calculated. The money value was determined by multiplying the yield per statute acre by the value of the grain on the Dublin market determined by expert valuation.

The result obtained was styled the "Value per acre."

I will now describe, in as few words as possible, the more important results obtained with the different barleys during the investigation.

Archer.—This variety of narrow-eared barley, which is well known and appreciated in our English eastern counties on account of its high yielding capacity and stiff straw, proved in the Irish experiments to be the most profitable of all the varieties of barley just referred to. The average yield per acre throughout the whole course of experiments was 5 qrs. 25 st., and the value per acre was £8 15*s*. After most careful statistical examination this proved to be 12*s*. more than the nearest competitor in the investigation, and 16*s*. more than the nearest narrow-eared variety. The quality of the barley was generally good, although it was somewhat dull in appearance and less attractive looking than true Chevalier barley; on the other hand it usually proved to be the better material in the malthouse. Somewhat late ripening appeared to be its only drawback throughout the Irish experiments. The somewhat late ripening and dull colour of Archer barley as compared with Chevalier are points well recognised in this country, and are

* For this information I am indebted to a report on "Barley Cultivation in Ireland," printed for private circulation by Messrs. Arthur Guinness, Son & Co.

evidently not peculiar to the Irish cultural conditions.

Scotch Chevalier.—This variety proved to be distinctly inferior to Archer, its "value per acre" being 16*s.* less. The estimated probable error of this comparison is 1*s.* 6*d.*, and the odds that Archer is better than Scotch Chevalier on the farms and during the seasons tested are over a million to one. I may add that I am not responsible for the very sporting manner in which this latter statement is expressed; I quote direct from the Irish report. The "probable error" and "odds" mentioned in this report have been determined by the most approved mathematical means.

Old Irish.—The results obtained with this variety were very poor. Its value per acre as compared with Archer was 22*s.* less.

Hallett's Chevalier.—This variety was even more disappointing than Old Irish, and its value per acre was 29*s.* less than that of Archer.

Danish Archer.—This variety appears to have been derived from a true Archer barley originally imported from our eastern counties into Denmark a number of years ago. It is now very largely cultivated in that country, and is recognised as the best barley grown there. In Ireland this barley proved even better than the ordinary Archer referred to, and its value per acre came out 11*s.* higher.

The broad-eared barleys tested were Goldthorpe and Standwell. Compared the one with the other, the value per acre of Goldthorpe was 16*s.* more than that of Standwell, and the odds that Goldthorpe is a better barley than Standwell are over a hundred thousand to one. In appearance there was apparently little to choose between the two; Goldthorpe, however, proved to be better malting material than Standwell. The smaller yield of Standwell was apparently due to a characteristic it possesses of producing a very considerable number of "deaf" ears. This originates from a general tendency in this hybrid barley of some of the florets to escape fertilisation.

The result of the Irish investigation up to this point proved that Archer (excluding Danish Archer) was the best of the narrow-eared barleys examined, and Goldthorpe the best of the wide-eared varieties. But a careful comparison of the relative merits of these two barleys was very desirable, because there is a general idea in Ireland that wide-eared barleys are more suitable for certain districts and narrow-eared for others. A similar impression exists in this country also, and therefore the results of the Irish investigation in this direction are peculiarly interesting.

Throughout the investigation extending over six years, Archer and Goldthorpe were grown side by side at farms scattered over the whole of the barley-growing districts of Ireland, and in all fifty-one comparisons were made. From a general average of the results obtained, the value per acre of Archer was found to be £8 15*s.* as against £8 3*s.*, the value per acre of Goldthorpe—an advantage of 12*s.* in favour of Archer. The calculated odds that Archer was a more profitable barley than Goldthorpe are about twenty thousand to one. From a general average of all the experiments, therefore, Archer proved to be a better barley from the farmer's point of view than Goldthorpe. Moreover, when the experiments where sub-divided into different districts the same result was obtained, Archer proving to be the better barley in every case.

District.	No. of Tests.	V.P.A. in favour of Archer.	Probable error.	Odds in favour of Archer.
		s. *d.*	*s.* *d.*	
Cork . . .	12	11 0	4 7	10 to 1
Wexford . .	10	10 0	5 0	7 „ 1
Louth . . .	8	15 0	5 7	10 „ 1
Central Plain	21	12 0	3 5	100 „ 1

The conclusion finally arrived at is, that although certain individual soils may still be found which suit Goldthorpe better than Archer, there is no doubt that in the vast majority of cases it will pay the farmer better to grow Archer. This conclusion, of course, applies to Ireland where the experiments were conducted, and where agricultural and climatic conditions are somewhat different from those of this country, but nevertheless there appears to be no *prima facie* reason why future investigation may not demonstrate a similar conclusion here. In this respect alone the Irish experiments are well worth the attention of the agriculturists of this country.

The advantages of purity of seed is another question of great importance which is brought into conspicuous notice by the Irish investigations. During the course of the experiments, it became evident that ordinary, so-called, pure seed of any of the varieties of barley tested, represented a mixture of various strains. Differences of growth and habit, of size of ear,

of time of ripening, and other factors of a minor character, demonstrated the mixed nature of the seed ordinarily cultivated, and evidenced that in any thorough investigation of barley for the purpose of ascertaining the most desirable kinds to cultivate, absolute purity of the seed must be assured. In order to meet this demand, in the first instance pure seed was obtained from a single selected plant or ear of the particular variety under examination, and it was sown under conditions which precluded any chance of accidental admixture. Harvesting and re-sowing were afterwards continued with every precaution to preserve purity, until a crop of pure seed was obtained sufficiently large for cultivation on a farming scale. Subsequently experiments were conducted in which the pure selected seed was grown on a number of farms side by side with the ordinary seed from which the pure strain was originally derived. In all cases the crops grown from selected seed not only exhibited remarkable evenness of growth as compared with those grown from ordinary seed, but the yield at harvest time was also distinctly larger. In the case of Archer, the mean of eleven different experiments demonstrated that the value per acre of the crop from selected seed was 11*s*. more than that of the crop from ordinary seed. Experiments with selected Goldthorpe also showed a somewhat similar gain in value as compared with ordinary Goldthorpe. In fact, the Irish experiments demonstrate to a point of certainty that a great gain may be achieved by proper attention to the selection of pure seed. What this gain would represent for Ireland alone is estimated in the report of the Irish experiments. "If," the report says, "pure selected Archer or Danish Archer were substituted throughout Ireland for the existing varieties, it would result in an increase of yield of six bushels per acre, which would mean an increase in the value of the yield of over £200,000."

There is much more in the valuable report of the Irish experiments on barley culture to which I should like to refer if time allowed, but I must bring my remarks to a conclusion.

I have referred in this lecture to the leading results obtained from the Irish experiments, because, in the first instance they demonstrate the limit of our present knowledge with regard to barley cultivation; and, secondly, because they indicate how much can be done for the good of agriculture by the joint action of the agriculturist and the brewer.

In this country the cultivation of barley still awaits systematic investigation, and every year very many thousands of pounds are lost to agriculture from the lack of knowledge which is undoubtedly attainable. Is it too much to hope that, following the example of Ireland, joint action between the agricultural and the malting and brewing interests may be arranged in order to facilitate a thoroughly systematic investigation of the subject? The prize is a very large one, and, moreover, it is certain of attainment.

No doubt misunderstanding to some extent does exist between the agriculturist and brewer which tends to keep them apart, but, as I have said before, it is based on misconceptions. There is nothing in the economic conditions of brewing which is antagonistic to the welfare of agriculture; on the contrary, the two industries possess many interests in common. Why should not these common interests prevail over misconceptions, and bring agriculture and brewing together for the carrying out of a joint work which would confer great benefit on both industries?

HENEQUEN AND BANANA CULTIVATION IN MEXICO.

The State of Colima is peculiarly adapted for the henequen plant (*agava rigida elongata*), which produces the sisal hemp of commerce. The foot-hills are generally barren of timber, and are often covered with grass, the soil being thin and sometimes rocky, but the climate and all the conditions are perfect for the cultivation of this plant. There is little labour in growing henequen, or in harvesting the crop, and the machinery necessary for the separation of the fibre from the leaves is cheap, and can be worked by the natives. It has been customary in Mexico to cultivate henequen without regard to the number of plants to an acre or to their position. The United States Consul at Manzanillo says that sometimes as many as fifteen hundred are put on an acre of land. The plan usually adopted is to plough and prepare about ten acres of level land, to be used as a nursery, in which the small plants are set six inches apart in rows two feet apart. In this manner, while the larger field is being prepared the young plants acquire a vigorous growth. As the fields are planted, the stock from the nursery is replaced until the first ones set out produce suckers, which may be taken up and left in the sun for two or three weeks, as this makes them better and stronger. Plants in the field are set six feet apart in rows nine feet apart. During the first two years, if the ground is not too rocky, it is planted with maize or beans. After this the henequen requires air and sunshine, and needs no care or cultivation. When the plant commences

to mature (fourth year), the leaves can be cut at any time during the dry season, and every twelve months thereafter. During the first four or five years the plant will produce from fifty to sixty "suckers," which may be used for transplanting. The net profit from the production and sale of sisal fibre is said to be from £20 to £33 per acre. As the henequen plant lives and produces for fifteen or twenty years, without being transplanted, and is not attacked by insects or disease, and requires little expense for harvesting, it possesses a great advantage over crops which have to be planted each year. In many districts of the State of Colima irrigation is not necessary, and banana bulbs may be set out at any time of the year. The native banana (manzana) will not bear transportation for any distance, and for this reason the Governor of Colima appointed a commission to inspect the "Roatán" variety, which is grown in the State of Tabasco. The commission returned with 25,000 bulbs, which were distributed amongst the farmers. The "Roatán" banana is of good size, has a thick skin, fine texture, and is free from fibre and lumps, and has found favour in the American markets. The soil in which the banana is planted should be a sandy loam, and when ploughed and harrowed the ground is measured in squares of three metres (metre = 39·3 inches), which gives about four hundred plants to the acre. When the sprouts reach the height of one foot they may be transplanted. When the land is marked into squares, a hole three feet square and three feet deep is made, the plant being placed in the centre. The reason the bulb is planted at this depth is because of the accumulation of leaves and *débris* which form a fertiliser, and also retain the moisture. The land being set with bananas, may be planted with maize or beans, thus reducing the cost of cultivation the first year. It requires twelve months for a stock to mature and produce a bunch of fruit from the bulb. During the growth of the first stock there will come several shoots, the largest one being allowed to stand, while the others are taken up and replanted. The stock left will attain sufficient growth to produce one bunch of bananas in four months, or three bunches from one plant, or 1,200 bunches per acre annually. Planters receive tenpence per bunch at the plantation, and as the cost of production is £10 per acre, very satisfactory profits are realised. A very fine fibre is extracted from the banana stock, which is used in the manufacture of hammocks.

WOMEN IN JAPANESE INDUSTRIES.

Japan is seriously discussing the advisability of passing laws to regulate labour in its factories, to affect more particularly the hours of labour of women and girls. An interesting statement has been made by the Director of the Industrial Bureau of Japan, which shows how far women are responsible for building up Japanese industries. This report shows that Japanese women's labour as an industrial factor is very great, their influence being keenly felt in almost every industry. Commencing with the production of raw silk, which occupies over 50 per cent. of Japan's total export trade, female labour largely enters into the manufacture of habutar (silk goods), cotton yarn, and other staples of export. The extensive employment of female labour may be due to its comparatively low price, but in many instances work can be done better and more effectively by women than by men. The percentage of women engaged in the industries of Japan is stated to be as follows, as compared with men: Men employed, 34 per cent.; women employed, 66 per cent.; showing that there are nearly twice as many women as men employed. There are usually fixed hours (twelve) as to the time for daily employment. In spinning raw silk, floss silk, cotton, weaving, knitting, and braid manufacture, there were employed, in the latest year for which the figures are available, a total of 373,284 persons classified as follows: Males over 14 years of age, 40,789; under 14 years of age, 2,475; total number of males, 43,264. Females over 14 years of age, 296,424; females under 14 years of age, 33,596; total number of females, 330,020. The wages paid to males over 14 years of age ranged from one shilling, the highest rate, to sevenpence halfpenny. Males under 14 years of age received from fivepence to as little as threepence per day. Females over 14 years of age receive from sevenpence, the highest rate, down to fivepence per day. Females under 14 years of age received from fourpence halfpenny per day down to twopence halfpenny. From this report it will be seen that the wages paid to factory operatives are very small indeed. This fact is also applicable to all other kinds of industrial labour. It is not surprising therefore that Japan's export trade has increased from 13 millions sterling in 1891 to over 46 millions in 1910.

CAMPHOR PRODUCTION IN BURMA.

The camphor tree, principally the *Blumea balsamifera*, seems to be indigenous to certain parts of Burma, and the experiments conducted by the Forest Department to cultivate the *Cinnamomum camphora* show that this tree can be successfully grown in the Upper Chindwin, Myitkyina, and Bhamo districts, as also at Momeik, while in Maymyo the tree is said to flourish. The experiments of the past few years go to show that it can be successfully grown in Upper Burma, and the species is also expected to do well at suitable elevation in the Shan States. There is, therefore, according to the American Consul-General at Calcutta, a fair possibility of a camphor plantation on a large scale in Burma proving successful and profitable, and there is no reason, it is said, why a camphor industry should not be started in the province. The question of camphor distillation in Burma was recently considered by the Forest Department. The first point was to design an

experimental still of sufficient capacity to see if camphor could be manufactured on a commercial scale from the *Blumea balsamifera;* the next point required a chemical investigation to determine the percentage of essential oil in the fresh green plant, and compare it with the percentage obtained from the plant in its dry state. These analytical determinations were made with the plants growing in the Toungoo and Katha forest divisions, and the results show that the branches and leaves of the *Blumea balsamifera* can be profitably distilled for the extraction of the oil and camphor. In North Hsenwi the leaves and thinner twigs are gathered, though mature leaves are preferred, and placed in a bamboo basket, which is put into a large pot containing water, but not touching the water, and on top of the basket a chatby (vessel) of cold water is placed. Fire is then applied. The steam from the water in the large pot passes through the basket, and the cold water on top, which is frequently changed, acts as a condenser. In a few hours the operation is completed, and on the leaves being removed the camphor is found adhering to the sides of the basket. It is then scraped off and placed in bamboo tubes. The yield varies according to the quality and quantity of leaves used in the operation. The camphor finds a ready market locally, as it is largely used as a medicine. The trade is insignificant, as the people extract the camphor only when they have nothing else to do. In Kengtung, on the other hand, a considerable export trade exists with the southern Shan States.

THE RUSSIAN PAPER TRADE.

Russia's paper-mills depend almost entirely on Finland, Germany, and Austria-Hungary for raw material, which dependence is supported by the present preferential tariff in favour of Finland. On account of Finland's proximity to Russian ports of entry, wrapping and wall-paper are carried frequently in ballast. Paper manufacturing has been so long concentrated in the hands of the Finlanders, and the technical features so constantly improved by introducing inventions in machinery and discoveries in chemistry, that paper-making in Russia is also more or less dependent upon Finland. In Finland, according to a recent report of the American Consul at Moscow, 158 factories manufacture paper and paper goods, employing about 15,000 workmen, with an annual output of, approximately, £1,800,000. Forty years ago the paper-making industry in Finland was of little importance. Small beginnings were commencing to show possibilities of future development in the early eighties, and the example of Norway and Sweden did much to stimulate Finland in this direction. In 1885 about 2,000 persons only were employed in the paper and pulp industry. This number had increased in 1895 to 4,000, and in 1905 to 11,000. It is estimated that now 15,000 people are working at the factories and mills. Finland and Russia combined furnish only about 3½ per cent. of the total amount of paper produced in Europe, yet on account of immense extents of forests, accessibility to the ocean and numerous waterfalls, the former is certain to play a most important part in the world's future market. The paper industry is carried on extensively at many important commercial centres in Russia, including the provinces of Moscow, St. Petersburg, Novgorod, Livonia, Vladimir, and Kaluga. It also prospers in the governments of Perm, Vologda, Kiev, Vilna, Tula, Viatka, Kostroma, and Vitebsk. Six factories produce mechanical wood-pulp; five manufacture sulphite-pulp, and three specialise in cellulose products. The majority of mills manufacture "boards" and "wrappings." About fifty concerns produce cardboard, and the same number wrapping papers. In newspapers, only seven mills are working for Russian requirements, though there is a disposition to increase the number so as to supply the entire trade of the country, which is in the hands of the Finns. Formerly all cigarette paper was imported, but recently Russians have undertaken to supply themselves, as the demands are incredibly large. They appear to be succeeding in the manufacture of this kind of paper and its subsequent fabrication into tubes, which are supplied with a cardboard mouthpiece. A simple machine was invented some years ago by a Russian for filling the tubes with tobacco, of which one pound will suffice for 1,000. Many factories found in the country are provided with machinery of the latest type and run by electric motors, while many are content with old-fashioned equipments. Competition in paper-making is keen, but various firms in Moscow report that profits under favourable conditions are high, reaching sometimes 60 per cent. This applies especially to the production of cellulose, both bleached and unbleached, of which Finland appears to have the advantage in the means of manufacture. Russians have attempted at several places to compete, but they failed because their products were inferior to the imported ones, and the cost of production was almost prohibitive. Russia manufactures every quality and design of paper, but local dealers state that, as a rule, products are inferior, excepting news paper, which is claimed to be superior to that manufactured in Germany and Austria, the texture being firmer and the gloss more pronounced.

HOME INDUSTRIES.

The Railway Strike.—The railway strike of last week was by far the most serious that has occurred in our railway history. Happily it had lasted only two days when a truce was arranged by the acceptance of the Government proposal to investigate the working of the Conciliation Agreement, and to report what amendments, if any, are desirable in the scheme, with a view to the prompt and satisfactory settlement of differences. It is thought by some that, but for the misunderstanding of the Prime Minister's first offer of a Royal Commission,

this solution would have been accepted on the 17th inst., and a strike averted. Later in the day Mr. Lloyd George more fully explained the proposal, namely, a small Commission of five, two representatives of the employers, and two of the workmen, with a neutral as chairman, to inquire into the working of the Conciliation Agreement, to sit continuously, and to report without delay, the assurance being added that, if necessary, Parliament shall deal with the recommendations forthwith. Unfortunately this elucidation came too late to prevent the strike, but fortunately for all concerned the arrangement foreshadowed was accepted late on Saturday night, and the men were to resume work as soon as possible, none being punished for the part they played in the recent disturbances. There can be little doubt that there is substance in some of the complaints of the men, and nothing is to be gained, and much may be lost, by treating, as some leading newspapers have done, the demands of the men as midsummer madness, probably due in large part to the abnormal heat. The first complaint of the men is that they cannot get their grievances properly sifted. In 1907, when the Conciliation Boards were formed, it was pointed out that the exclusion of trade union officials from representation upon the Boards would breed trouble. There is no great industry in the country, other than the railway industry, where the wage conditions do not come before joint boards consisting of representatives of employers' associations and of trade unions, and these joint boards have been of great assistance in settling disputes in a peaceable and friendly manner. The railway companies defend their refusal to admit trade union officials to the Conciliation Boards on the ground that less than one-fourth of the railway men belong to trade unions. But there is one exception to this general refusal of the railway companies. The North-Eastern has negotiated with trade union officials for many years, although not recognising them as representing the whole of the employees, and the arrangement has worked advantageously to all concerned. Without trade union officials—always a moderating force in these days—to represent them, the men are not strong enough to enforce the most reasonable claim. Again, new and more scientific methods of operating the traffic have compelled the men to work more strenuously, so that, even where the rate of wages is slightly higher than it was, in proportion to the effective work performed it is less. And this at a time when the cost of living has increased, and is increasing. Under present conditions the public, especially in the passenger service, are better served by railways, and shareholders are beginning to get a somewhat better return upon their capital, though even now it is only about 4 per cent.; but the position of the men has not improved. Nor is it likely to improve until the directors call to their assistance the trade unions, whose special task is to secure fair treatment for the operatives, to obtain for them a fair rate of wage, having regard to the rising cost of living, and standard of comfort. In urging this view of a great and complicated question, no support is given to the action of the men in issuing what may be called their twenty-four hour ultimatum—an action calculated to alienate the sympathy of their best friends.

Electric Traction.—A writer in the *Times* (August 14th) asks why it is that electric traction in this country does not pay those who find the capital for working it? It is not a sufficient answer to say that in years gone by there was extraordinary difficulty in obtaining power to construct, and afterwards over-regulation, which greatly increased both the first cost and working expenses. England should be the most eligible country in the world for electric-traction schemes, yet, judged by the standard of comparable industrial securities, the average return on the many millions invested by municipalities and companies in urban, suburban, and inter-urban transit is painfully insufficient. The writer in the *Times* finds the solution of the puzzle in the small fares charged. The price of travelling is too low, and it is solely because of under-payment by the passengers that practically the whole list of electric traction undertakings in this country consists of insufficiently remunerative systems—from tube railways down to small tramways and light railways. It is not a popular view, but there is much to be said for it. In the period of horse tramways — about 1878 — the average receipts per tramway passenger were 1·84*d.*; in 1898, when there were numerous steam lines, it was 1·23*d.*; in 1910, with almost universal electric working, it was only 1·09*d.* Meantime labour conditions have become more onerous, and constructional maintenance and renewals more costly.

Imports of Corn.—In the volume of agricultural statistics just issued by the Board of Agriculture and Fisheries the figures relating to the imports of corn in 1910 are given. From these it appears that the importation of wheat was the largest on record, exceeding the previous highest, that of 1904, by 826,000 cwts. Flour imports continue to decline, being just under 10 million cwts., or 1,092,000 cwts. less than in 1909. The feature of the year's importation of grain was the unprecedented receipt of 28,942,000 cwts. from Russia. This total was over 11,000,000 cwts. (62 per cent.) greater than in 1909, and nearly 3,400,000 cwts. more than the previous highest importation from Russia, that of 1905. Record consignments were also received from Australia, the total of 13,117,000 cwts. being 3,417,000 cwts. more than in the previous year. The contribution from Canada was slightly less than in 1909, but otherwise had not been previously exceeded. On the other hand, Argentina, Chili, and the United States supplied nearly 10½ million cwts. (28 per cent.) less than in 1909. Supplies from the British Empire overseas formed in 1910 a higher proportion (35·2 per cent.) of the total than in any of the six preceding years.

Wool.—The total quantity of sheep, lamb, and alpaca wool imported in 1910 was 803,000,000 lbs., or only 5,000,000 lbs. less than in the previous year, when the imports were the highest on record. Re-exports amounted to 335,000,000 lbs., leaving 468,000,000 lbs. as the net amount retained for consumption, an increase of 50,000,000 lbs. over the net imports of 1909, and of 17,000,000 lbs. over the net imports of 1907. The year 1910 therefore created a new record in this respect. The proportion of total imports from British possessions was 83 per cent., about the same as the previous year. The supplies from South Africa and India were somewhat smaller, but Australia and New Zealand shipped larger quantities, the latter country thus surpassing the record only made in 1909. Most European countries sent smaller supplies, but France and Germany were exceptions. Imports from Argentina and Uruguay fell from 47 million to 36 million lbs., but those from other parts of South America increased.

The Crystal Palace.—The Crystal Palace, with all it owns, theatre, concert-room, picture galleries, park and gardens, statuary and casts, books and curios, premises covering ground-rents amounting to nearly £1,500 per annum, is in a few weeks to be offered in one lot, as a going concern, at public auction. Meantime there is a movement on foot to raise a million sterling by public subscription for its purchase as a memorial to King Edward, and another project will form the subject of discussion at a meeting shortly to be held at the Mansion House, under the presidency of the Lord Mayor. It may be doubted whether the Palace can be saved for public purposes unless with the help of Parliament, and that would not be easy to get. The financial record of the Crystal Palace has been consistently disastrous. Opened in 1854, much was expected of it, and of the public support it would win, but it soon got into serious financial difficulties, the shareholders received no dividends, and as far back as 1887 the Company defaulted in payment of debenture interest. Reconstructed, it defaulted on its second debentures in 1891. Fresh working capital was introduced, but with no success. Before the Receiver was appointed early in 1909 the outstanding debentures stood at £500,000, and the ordinary capital had become a negligible quantity. At last the debenture-holders are seeking to enforce an absolute sale.

The American Cotton Crop.—At the end of last week the Liverpool quotation for American cotton was 6·66*d*. per lb., as against 8·07*d*. per lb. a year ago, and 6·69*d*. per lb. in 1909. As late as May last the grade now quoted at 6·66*d*. was quoted at 8·42*d*. per lb. The main cause of the drop is of course the continuance of brilliant weather conditions in the American cotton belt. The present expectation is that the growing American cotton crop will be the largest yet grown, and will come to port early enough to dissipate the pinch which has seemed almost certain to mark the finish of the present season. The estimate of crop conditions published by the Washington Agricultural Bureau at the beginning of the month, placed it at 89·1 per cent. (100 being theoretical perfection) in comparison with 88·2 a month earlier, 75·5 per cent. this time last year, and 71·9 per cent. this time two years ago. The total crop of 1908 was 13,829,000 bales; of 1909, 10,651,000 bales; of 1910, about 11,800,000 bales; but whereas the estimated acreage in 1908 was only 33,370, this year it is 35,004 acres. The visible supply at July 28th was in 1909, 2,145,000 bales; in 1910, 1,331,000 bales; in 1911, 1,313,000 bales. The outlook at the moment is unexpectedly favourable, but it is well to remember that the most critical months are still to come. It must not be forgotten, too, that the sanguine estimates of the Egyptian crop, current some time ago, have been greatly modified by reports as to the ravages of worms, and anything that hurts the Egyptian cotton crop affects Lancashire in a peculiar degree, since the fine counts are made very largely out of Egyptian cotton.

Soya Beans.—A Yellow Book published by the Chinese Imperial Maritime Customs, and dealing with the subject of developments in Manchuria, refers in the following terms to the Soya bean:—"The Changchun-Kirin railway, now under construction, will in a couple of years open the way to the development of the Sungari region to its fullest capacity, and if this line is continued to the Korean frontier new districts will be thrown open, while the Chinchow-Aigun line, or at least a portion of it, would, if constructed, traverse a country where beans might thrive. The eager competition to secure beans in Europe shows no signs of slackening; and the North American continent appears to be about to enter the field as a consumer, for a large shipment of beancake has just been sent to Seattle, and there appears to be a very good opening for the product on the Pacific coast, where the heavy railway freights from the East have caused dairymen and feeders to look round for a cheaper feed than that which comes across the Rockies. With freight from Darien to Seattle at only (gold) $4 per ton, a good market should be developed. Soya beans are being grown in British West Africa, and experimental planting is carried on in practically every British colony; but it seems doubtful whether such experiments can meet with success in competition with the Manchurian product, which is raised under ideal climatic conditions and by the cheapest possible labour. The general impression prevailing seems to be, therefore, that the bean trade has a good future before it; that the time of stress through which it is passing will not last much longer, and that business will settle down when once normal conditions have been restored."

The Railway Dividends.—Increased traffic, due to more active trade and industry, and greater economy in working, have produced very satis-

factory results for the first six months of the present year from the dividend point of view, notwithstanding increase in working expenses. For this increase is 1 per cent. less than the rate at which the gross receipts improved, showing that the working cost was smaller. The proportion of expenditure to gross revenue was only 63·7 per cent., against 64·3 per cent. for the corresponding half of 1910. With only two exceptions — the Great Northern and London and South-Western, which show no change—all the great companies have increased their rate of distribution, and all but two have carried forward more than a year ago. The Midland dividend is ¾ per cent. more than for the first six months of 1910, and the London, Chatham and Dover is able to pay the full amount due for the half year on the Four and a Half Per Cent. Arbitration Preference against only 3 per cent. Every other company paying dividends on its ordinary stock has increased its rate of distribution by ½ per cent., with the exception of the two companies named above.

CORRESPONDENCE.

CANTOR LECTURES ON "ETCHING."

When anybody with some knowledge of an intricate subject, treats that subject before audiences in a couple of lectures intended to be as little dull as may be, and spreading perhaps germs of knowledge, there is generally somebody who thinks it "only right" to point out that another treatment of the subject than that adopted deliberately is at least possible. This singularly obvious fact is really all that Mr. J. Pennell, stirred by a holy wroth, has conveyed to us in his scheme for lectures on ' Etching" so preferable to mine, except, indeed, his wish to be disagreeable to me—which might have been taken for granted.

My claim for attention to Bega's etchings—much less lengthy, by the by, than Mr. Pennell angrily states—is inadmissible, it appears, only because Mr. Pennell is "blankly ignorant" of them. Much else would be inadmissible on such a reason assigned.

Those living Etchers whom I praise, and whom Mr. Pennell does not approve of, he prudently avoids particularising. To Mr. Pennell—a one-sided person who, with one idea to occupy his head, finds that head much too full to entertain any second or third—it cannot, of course, occur that had I spoken at length of Vandyke or Piranesi, much about others must have been omitted that certainly needed saying. If, indeed, I left out Turner, that was because his etchings were only intended to be brilliant preparations. Even Mr. Pennell probably knows that my books contain tributes to him. Sir Charles Holroyd and Mr. Spence—Mr. Pennell's new-born enthusiasm for whom I heartily welcome—were mentioned in the lectures if not in the report. I have for years made their eulogy. As for the Belgian, Rops, I am content to leave to Mr. Pennell the monopoly of enjoyment of Rops' singularly uninteresting indecencies.

But why continue, since Mr. Pennell's whole complaint is based on the delusion that it is the business of a couple of lectures to contain all the material of an exhaustive treatise? Let him "wait and see"—in the later autumn—my largest and, I suppose, final volume on the subject of which he would wish us to think I know so much less than he does. But then, again, one has to remember that it is possible to "wait" and still not to "see."

A parting shot! I am, it seems, no authority on Etching. And that is doubtless why, when Mr. Pennell's own prints were issued and exhibited in his own land, two or three years ago, his publishers, as Mr. Pennell knows well, thought it particularly worth while to invite me to write, for the American public, an introductory word about them.

Peace be with him! FREDERICK WEDMORE.

NOTES ON BOOKS.

REGIMEN SANITATIS: THE RULE OF HEALTH. From the "Vade Mecum" of the Famous MacBeaths, Physicians to the Lords of the Isles and the Kings of Scotland for several centuries. By H. Cameron Gillies, M.D. Dedicated to the Marquis of Bute. University Press, Glasgow: Robert Maclehose & Co., Ltd. 1911.

Here is a book that, within its class, outwings all commendation. It is the fourth of a series entitled "The John Ryland Facsimiles," consisting of the reproduction in facsimile of old printed books and MSS. in the possession of the Governors of the John Ryland's Library, Manchester. The first volume of the series, reproduced in 1909, with an Introduction by Mr. Henry Guppy, was "The Propositio" of John Russell, printed by Caxton, *circa* 1476; the second, reproduced in 1910, with an Introduction by Mr. Henry E. Newberry, and a Vocabulary by C. Wyld, was "A Booke in Englysh Metre, of the Great Merchauntman called 'Dives Pragmaticus,'" printed by Alexander Lacy, *circa* 1563; and the third, reproduced in 1910, with an Introduction by Mr. Guthrie Vine, M.A., "A litil Boke for the Pestilence" ["Black Death"], printed by John Lettou, *circa* 1485. The first and third are mere tracts, far more interesting on account of their printers than their contents, and owe their preservation to having been printed, and bound; for once printed and bound, "A book's a book—although there's nothing in 't." The second is most interesting, as giving in about 112 prefatory rhymed lines and 74 rhymed quatrains, a complete list of the craftsmen and merchants' wares that made up the daily traffics of the home and foreign trade of the period. The titlepage

refers the reader rather widely to "Deut. 23" and "Levit. 19," the reference undoubtedly being to Levit. xix. 35-6: "Ye shall do no unrighteousness in . . . meteyard, in weight, or in measure. Just balances, just weights, a just ephah [for dry goods], and a just hin [for liquid] shall ye have." The book would have delighted Sir Henry Yule, the greatest of English exponents of the mediæval commerce of the historical Old World. But this fourth volume of "The John Ryland Facsimiles" far surpasses the rest of the series in the fourfold praises due to it, for its intrinsic attractiveness, its scientific value, the scholarly translation by Dr. Cameron Gillies of its text from the original Gaelic, and his learned notes in exposition of it. As edited by Dr. Gillies, the volume is a most inspiring guide through the tangled history of the evolution of mediæval medicine in Scotland, and, indeed, Great Britain; and in its lesser degree proves, as was once and for all proved by Sir Henry Yule's "Marco Polo" and his glorious "Glossary" [Hobson Jobson], that in the hands of the predestined man, books on the driest and least considered subjects, became veritable "talismans and spells."

The true form of the name MacBeath is Machbeathadh, meaning "Son of Light," and from the eleventh century it has been a "kenspickle" name in its numerous widely-varying forms of McBetha, McgBeth, Bead, Beda, Betune, Beatoun, Biotun, Peudan, Peden, etc., in north-western Scotland; while Bethune in eastern Scotland [Fife] may be another form of the name. The MS. of the MacBeath's *Regimen Sanitatis*, was "discovered" by Dr. Gillies himself in the British Museum; and his Introduction to the volume before us traces it through some of its wanderings during the past three hundred years, until it found its safe, if for a while cryptic, refuge in the Museum. It may be identified as the "Vade Mecum" of John MacBeath, who lived about the middle of the sixteenth century; and is probably based on similar note-books that had been transmitted, with ever-increasing additions, from generation to generation in this family of famous Scottish physicians. Apart from the accumulation of experience in the practise of their profession, the MacBeaths' knowledge of medicine by reading seems to have included all the best available in their time. Martin, "Gent," who travelled in the north-west of Scotland in 1700, states that "Fergus Beaton in South Uist possessed the following MSS., namely, Avicenna, Averroes, Joannes de Vigo [Surgeon to Pope Julius II.], Bernardus Gordonus [author of *Lilium Medicinæ*], and several volumes of Hippocrates"; and Dr. Gillies adds: "John [MacBeath] might have sat for his portrait to Chaucer as his 'Doctour of Phisik':

Wel knewe he the olde Esculapius,
And Deiscorides, and eke Rufus,
Olde Ypocras, Haly, and Galien,
Serapion, Razis, and Avycen,
Averrois, Damascien, and Constantyn,
Bernard, and Gatesden, and Gilbertyn."

The stimulus given to the intellect of Greece, the vitalising intellect of the whole civilised world to the present day, by the emotional and spiritualising East, through the invasions of Darius and Xerxes, powerfully reacted on the East through the conquests of Alexander: centuries after which the now Hellenised East once again reacted on the West, through the propagation of Christianity and the conquests of the Saracens; who in this way served to uphold over western Asia, and northern Africa, and southern Europe, during the darker centuries between the fall of Rome and the fall of Constantinople, the ever-revivifying, reinvigorating, and reanimating traditions of Greek science and philosophy, learning and literature, and art; for Saracenic art also was but a recrudescence of Greek art applied to the uses of the Saracens, and the new world of Islam created by them. Of the schools of the New Learning, revived or founded in the wake of the Saracens, the three that became most famous were those of Monte Casino, originally founded by St. Benedict himself, A.D. 529, on the site, it is said [as said also of our St. Paul's], of a temple of Apollo, to which a medical school was now added; the greatest teacher wherein was Constantius Africanus [Chaucer's Constantyn] of Carthage [1018–87], a great Arabist, "Orientis et Occidentis Doctor," and translator of Hali's *Compendium*, under the title of *Pantegni*. The others, Salerno and Montpellier, were more especially medical schools. The School of Salernum, nicknamed "Civitas Hippocratica," was founded A.D. 1150, and its two notable works of permanent value, not only to the student of the history of medicine, but the medical practitioner, are the rhymed *Regimen Sanitatis Salerni*, and the *Compendium Salernitatum*. The former was addressed to Robert, son of William the Conqueror, "Anglorum Regi" [who was cured of a wound at Salerno A.D. 1101]; and it at once became, and for centuries remained, the "Vade Mecum" of every medical student and physician in civilised Europe:—I fancy because once read you never can forget the slow and steady tread, and sure and sober lilt of its admirable monkish Latin lines. When I was a student at Edinburgh, 1848–54, copies of the *Regimen* were still turning up at one and another of the sales of second-hand books there; and I possess five different editions of the book bought by me during those years. Montpellier was, like Edinburgh, a university [its sexcentenary was celebrated in 1890], wherein the teaching of medicine was the greatest feature; and it was there that Bernardus Gordon, of the *Lilium Medicinæ*, taught; and that other Scot named by Chaucer, John of Gaddesden, and Gilbert ["Gilbertyn"], "the Englishman," author of the *Laurea Anglica*, and a *Compendium Medicinæ*, were taught. The MacBeath "Regimen Sanitatis" is based, as Dr. Cameron Gillies well expresses it, in form, on Gaddesden's *Compendium*, and in substance, on the *Regimen Sanitatis Salerni*.

Turning to the text of the volume, what is most remarkable about it is the constant insistence,

implicit or explicit, of that counsel of perfection in all sane medicine,—prevention is better than cure:

"Principiis obsta: sero medicina paratur
Cum mala per longas convaluere moras;"

but enforced, not in the spirt of Ovid [Remed: Amor: 91–2], but of Thomas à Kempis in his reference to these lines in the "De Imitatione Christi" [I., 13, Hirsche 1891]. The Third Chapter, dealing with diet, is so simple in its prescriptions, and so pious in spirit, that it might have been written by a native Hindu "medicine man," who still follows the precepts of the Greek and Roman art of healing as received by him direct from his Aryan forefathers, or, at latest, through the intermediation of the Arabian writers on medicine. Stretch yourself well on awakening; bathe, and clean your teeth, not with a hard tooth-brush, but with the leaf of a melon or the skin of an apple. Then, with cleansed lips, say your "Hail Marys," etc. Next take a moderate walk; and on getting hungry take your food, and do not be too long before appeasing your appetite. Eat simply, and of one dish, and not too much of that. Food should not be taken more than twice a day, and indeed it would seem that once in sixteen hours was considered enough. The second daily meal, supper, should be light and short, sleeping on a full stomach being in every way injurious, more especially to the eyesight. Never bathe on a full stomach. Fat, or rich food, may be taken in winter, but should be avoided in summer. Milk should never be taken with fish [as it was thought to produce leprosy, a belief still held in India]. Sleep should be taken at night, not during the day; or if in the heat of noonday, let it be very brief. Never eat on a troubled mind. Such, in *précis*, is the MacBeaths' "regiment of eating and drinking:" and could anything be more sensible, or closer to the dietary regulations enjoined by the *vyds* and *hakims* of India, whether of the *Yonani* [Ionian], or "Greek" school, so called, or the *Misri*, or "Egyptian" [called also *Suryani*, *i.e.*, "Syrian"]: the Yonani traditions coming down from Hippocrates; he having derived them from the Egyptians, Persians and Hindus, going back possibly to the *Ayur Veda* section of the *Atharva Veda* of the Aryan invaders of archaic India.

I have said enough to demonstrate the deep and diversified attractions of the volume, and to justify my praises of it; and of its erudite and brilliant translator and editor. But I must add yet further expressions of gratitude to its printer and publishers. In paper, typography, "forwarding," it is perfect; and, whether accidentally or intentionally, most happy in its binding. Dr. Cameron Gillies knows how to quote from Chaucer, and either he, or his publishers, would seem, when considering the binding of this volume, to have had in mind Chaucer's lines on "A Clerk of Oxenforde"—

"For him was lever han at his beddes hed,
A twenty bokes, clothed in black or red."

When Chaucer wrote this he had in view the current colours of the cloth-wrapt books of his day, black, red, and blue, which continued to be the prevailing colours of bookbindings so long as cloths of various denominations were used in Europe for the purpose [v. National Gallery], as they are still used, in envelope form, for MSS. in India. The whole aspect of the binding of Dr. Cameron Gillies' volume is of the fifteenth and sixteenth centuries bound books, and this superadds to its other merits the talismanic touch, that after all is, in our heart of heart, the compelling spell of the rare books that in every detail set forth the good faith of everyone, author, printer, "reader," illustrator, paper-maker, binder, and publisher, concerned in their production.

GEORGE BIRDWOOD.

CACAO. By John Hinchley Hart, F.L.S. London: Duckworth & Co. 7*s.* 6*d.* net.

The late Mr. J. H. Hart—for he has, unfortunately, died since the completion of the work under notice—was well known as an authority on tropical agriculture and botany. He was superintendent of King's House gardens and grounds in Jamaica during their formation in 1875; superintendent of the Government cinchona plantations in 1881; agricultural director of the public gardens and plantations in 1886; chief of the botanical department in Trinidad in 1887, and for many years superintendent of the Royal Botanic Gardens in Trinidad. He also wrote various books and reports on cacao, forest conservation, and pamphlets on the cultivation of West Indian products, and he was responsible for introducing many of the existing varieties of cacao into Trinidad. His knowledge of his subject was, therefore, both theoretical and practical, and in the present volume he has given us a very complete and valuable manual on the cultivation and curing of cacao. Starting with a chapter on botany and nomenclature, he proceeds to deal with the question of selection of land, nurseries, planting of cacao, manuring, pruning, diseases and pests, and picking and harvesting; he then describes at length the operations for drying, etc., and the apparatus required therefor, and discusses generally the management of a cacao estate. The remarkable increase in the export of Trinidad cacao is doubtless due in no small measure to Mr. Hart. In 1891 the quantity exported was 16,188,493 lbs., valued at £439,786; this rose steadily till in 1908-9 the figures were 49,137,088 lbs., valued at £1,152,285. The world's production of cacao for the year 1910 is estimated at 478,800,000 lbs. Ecuador comes first, with 84,600,000 lbs.; San Thomé second, with 80,500,000 lbs.; and Trinidad third, with 67,500,000. Of British colonies (with a grand total of 138,500,000 lbs.), Trinidad is easily first, British West Africa ranking second with 55,200,000 lbs.

These figures will be sufficient to indicate the great extent of the cacao industry, and certainly every one interested in it would do well to study Mr. Hart's volume.

GENERAL NOTES.

The Study of Pellagra. — The second field commission for the investigation of pellagra has just left London for the Continent. It is composed of Dr. Louis Sambon, Lecturer at the London School of Tropical Medicine and Parasitologist to the Wellcome Physiological Research Laboratories, and Dr. Albert T. Chalmers, Lecturer on Pathology and Animal Parasitology, Ceylon Medical College. These two members of the Commission will be joined by Professor Haase, of Memphis, U.S.A., Dr. Cole, of Atalanta, U.S.A., and Dr. Martinez, of Yucatan, Mexico. The commission will proceed to the study of the epidemiology and etiology of pellagra in Hungary, the Austrian Tyrol, Spain, and the south of France. The Governments of Austria-Hungary and of Spain have shown great interest in the work of the Commission, and have granted every facility for the prosecution of the study they have in hand. Mr. H. S. Wellcome, so well known for the many services he has rendered for the advance of scientific medicine, especially of tropical medicine, and himself a member of the Pellagra Investigation Committee, has defrayed all the expenses of the present field commission. The work in Italy in the spring of 1910 by Dr. Louis Sambon, has gained so many converts to the belief that pellagra is not due to eating damaged maize, but to a parasitic disease conveyed by the bite of a fly, that Mr. Wellcome's timely help will enable Dr. Sambon and his colleagues still further to investigate a disease which causes widespread misery and fills the lunatic asylums in every region where it prevails.

Fire Precautions at the Coronation.—The British Fire Prevention Committee have published a report on the precautions taken to prevent fires during the Coronation celebrations. Some 14,000 bills were posted warning the public of the danger of carelessness in respect to smoking, matches, and the use of highly inflammable material such as muslin, voile, flannelette and celluloid articles; about as many slips and letters were sent to occupiers on the route of the procession and others, dealing mainly with the dangers of decorative materials, safeguards as to stands, illuminations, etc., and about four hundred newspapers and journals were induced to draw attention to the subject. Special preparations were made by the London Fire Brigade to ensure the safety of the Abbey. In various parts of the building there are thirty-one high-pressure hydrants, and the south-east tower contains a large water-tank with a capacity of 60,000 gallons. Direct telephonic communication is provided to the Westminster fire-station in Francis-street, a motor pump with crew was located outside the annexe, and during Coronation day picked firemen were placed at fixed points throughout the Abbey, each with an electric fire alarm in readiness to communicate with a general switchboard on ground level, from which a call could be instantly given to the firemen in waiting outside the building. It was no doubt owing largely to the action of the Committee that accidents were so few. On June 22nd only one fire occurred in a building on the Coronation route, and this was probably due to defective cooking apparatus. Only eight fires, attributable to the celebrations and illuminations, occurred in the evening. On June 23rd there was only one fire near the long route of the Royal progress, and two in the evening.

Public Works in Morocco.—Notwithstanding the disturbed state of the country, some little progress is being made in Morocco in the direction of public works. In his report on the trade of Morocco just issued, Mr. Consul-General White (Annual Series No. 4624) says that tenders have been invited for the construction of five sections of roads, and of additional buildings at the Tangier Customs House. Land telegraph wires are being placed to connect the existing wires from Casablanca with Rabat to the north and with Mazagan to the south, and the wireless telegraph apparatus at Rabat will be transferred to Saffi, so that all the western ports, except Laraiche, will be in telegraphic communication with Tangier and with the rest of the world. This will be a great boon to merchants. More important public works are in contemplation, but it is not yet known when tenders will be invited. The first to be taken up will probably be, says the Consul-General, (1) the erection of lighthouses and harbour lights, and placing of buoys where required on the coast; (2) Tangier waterworks; (3) harbour works at Tangier and Casablanca. There will also be further road construction and other minor works. The competition for the trade of Morocco continues to increase. As the ports are improved, and roads and bridges, and eventually railways in the interior are made, the trade of the country will be very largely increased. British merchants and manufacturers should, therefore, do all in their power to increase their hold on the market. British trade still maintains its position at the head of the list, notwithstanding the great addition to the French total by the trade across the Algerian frontier, which is classed as entirely French, though doubtless some of the goods are of British or other origin.

Tomato-Seed Oil.—The manufacture of an oil from tomato seed is an industry of quite recent date in Italy, where the growing and preserving of tomatoes is carried on extensively in many parts of the country. In the province of Parma alone, upwards of 84,000 tons of this fruit are packed every season. The utilisation of the seed, which forms so large a percentage of the waste in the process of packing, and which was formerly thrown away, must now add considerably to the profits of the packer. This oil somewhat resembles that of cotton seed in its properties, and it is beginning to be in steady demand for soap-making.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

BREWING AND MODERN SCIENCE.

By Professor ADRIAN J. BROWN, F.R.S.

Lecture II.—Delivered February 13th, 1911.

MALTING.

In my previous lecture I explained the position in which we now stand with regard to our knowledge of malting barley, and indicated the direction and manner in which further knowledge of great value might be obtained. This evening I propose to describe the position of scientific knowledge with regard to certain questions connected with the technical operations of malting.

In every operation of the maltster and the brewer we are brought face to face with biological problems of great complexity, but in none is this more conspicuously evidenced than in malting. The brewer has to obtain his sweet wort, a complex fermentable solution of organic matter mainly of carbo-hydrate and protein nature, from the hard contents of the barley corn of which only a very small portion is naturally soluble. In order to do so, empirical knowledge dating, probably, from pre-historic times, teaches that he must first make the seed germinate or commence to grow, and that the changes which then take place will enable him to accomplish his object. What are these remarkable changes which take place in the seed during germination, and how do they come about? To obtain an answer to these questions we have to investigate a most interesting problem of vegetable physiology, and one which, like all problems associated with life, appears to become more complex the further we push our investigations.

I propose to describe the progress of our knowledge relating to this problem of the germinating barley corn, and attempt to bring such knowledge up to date; before doing so, however, it appears desirable to say a few words about the nature and constitution of the barley corn. I hesitate to touch on so well worn a subject here, but I think a few minutes devoted to it now will materially assist my future remarks.

The barley plant is a monocotyledon belonging to the family of the Gramineæ or Grasses,

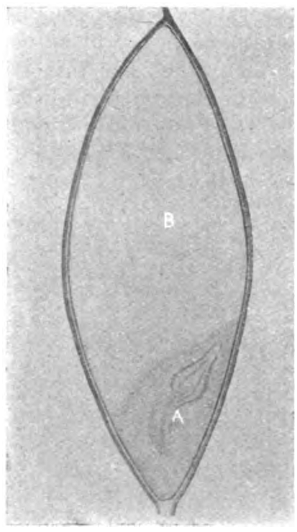

FIG. 5.—LONGITUDINAL SECTION OF A BARLEY CORN.

A. The embryo, or germ.
B. The endosperm, or starch-containing portion of the corn.

and its seed, typical of the seeds of all grasses, is constructed in a somewhat exceptional manner. A longitudinal section of a barley corn (Fig. 5) illustrates this. It will be seen that the germ or embryo of the seed occupies comparatively a small space at the lower end of the grain, and that the remainder of the space within the covering of the grain is occupied by the endosperm or starch-containing part of the seed. The latter part of the seed constitutes the food

reserve for the young germ, to be used in the early stages of its growth before it is sufficiently developed to live the life of a fully-developed plant. The seeds of all plants contain reserve material accumulated for this purpose, but the manner in which the reserve material is stored in the grass seed, and the way in which it is used, is exceptional. The food reserve of most seeds is stored within living tissue, or is otherwise directly associated with the germ, and its absorption during the growth of the young plant is the result of physiological processes of a so-called intracellular nature. But in the grass seed the food reserve has no direct connection with the germ, and is utilised by the germ through the agency of special physiological processes which are all important for the maltster. Fig. 5 illustrates the arrangement of the embryo and the endosperm of a barley corn. In the more highly-magnified representation of the germ end of a corn (Fig. 6), the germ and the endosperm adjoining it are shown more clearly. It will be noticed that they touch each other, but that there is no appearance of direct connection—in fact, the two parts can be easily separated without injury to either. The young plant, constituting the growing portion of the embryo, represented conspicuously by its plumule and radicle, may be seen lying within a mass of cells composing the rest of the embryo. When germination commences the plumule develops into the stem and leaves of the growing plant, and the radicle develops into its roots; but the portion of the embryo lying immediately in contact with the endosperm, which is called the scutellum, retains its position until the contents of the endosperm have been absorbed as food for the growing young plant; in fact the scutellum acts like the suctorial organ of a parasitic plant, and feeds the germ with food derived from the endosperm.

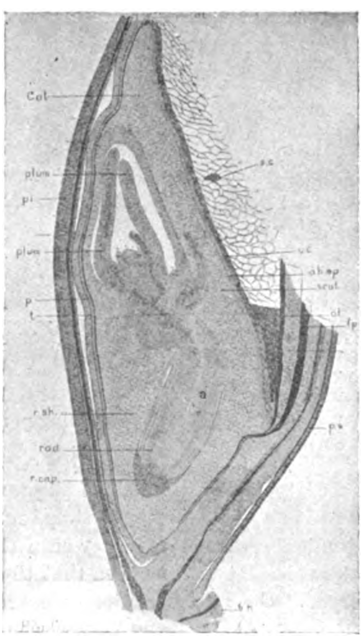

FIG. 6.—LONGITUDINAL SECTION OF THE GERM END OF A BARLEY CORN (HIGHLY MAGNIFIED).

"Plum," plumule; "rad," radicle; "scut," scutellum; "ab ep," absorptive epithelial layer. (After Holzner.)

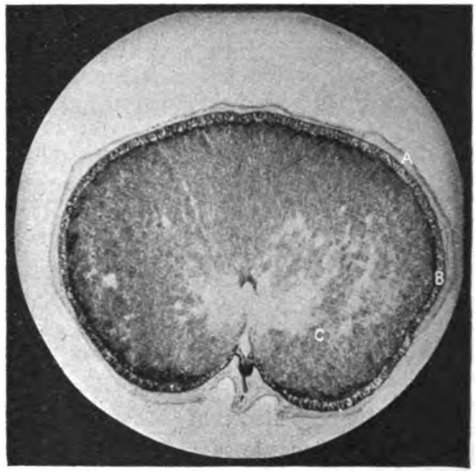

FIG. 7.—TRANSVERSE SECTION OF A BARLEY CORN.

A. Coverings of the corn.
B. Aleurone layer of endosperm.
C. Starch-containing cells of endosperm.

The endosperm of the barley corn is composed of two very different types of cells. The larger portion, constituting the white mealy part of the grain, is composed of thin-walled cells tightly packed with starch granules. Surrounding these cells is a layer of thick-walled cells situated immediately under the grain coverings which differ from the other cells of the endosperm not only in possessing thick walls, but also in not containing starch granules. These cells are called aleurone cells. The relative position of the two types of cells composing the endosperm will be seen in the photograph of a transverse section of a barley corn (Fig. 7). It is desirable however, to examine these two types of cells more closely as their constitution is of great importance with regard to the changes which proceed in the barley corn during germination. In a more highly magnified portion (Fig. 8)

of part of the endosperm it will be noticed that the walls of the starch-containing cells are thin and transparent. They are mainly composed of a form of cellulose closely resembling the cellulose of ordinary cotton-wool. When the starch-containing cells originally come into being during the development of the barley corn from the ovary of the barley flower, they are filled with living protoplasm in which starch gradually accumulates in the form of granules. As the seed approaches its ripening stage the starch granules increase in number and size until the cells are packed closely with them, and the remains of the original protoplasmic contents of the cells are crowded into the interstices between the starch granules (Figs. 9 and 10). Hence, when the corn ripens, the starch-containing cells are filled with starch

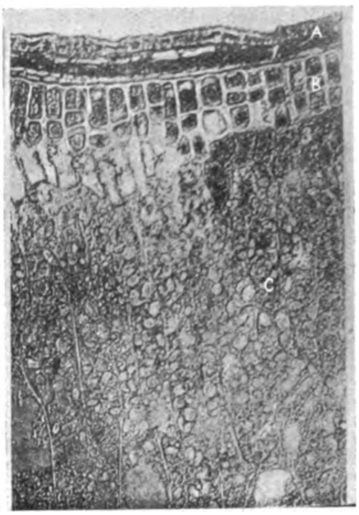

FIG. 8.—SECTION OF PORTION OF ENDOSPERM OF A BARLEY CORN (HIGHLY MAGNIFIED).

A. Coverings of the corn.
B. Aleurone cells containing no starch.
C. Thin-walled starch-containing cells comprising the greater part of the endosperm. The starch granules are visible lying embedded in the remains of the cell protoplasms.

granules lying embedded in the dried-up remains of the original protoplasm of the cells.

The nature of the aleurone cells constituting the outer layer of the endosperm will be more clearly seen in the enlarged photograph (Fig. 8). The cell-walls of these cells are very much thicker than the walls of the starch-containing cells, and are composed of somewhat different material. The aleurone cells contain no starch, but are filled with protoplasmic material exhibiting a granular appearance, and they usually possess very well-defined nuclei. I wish to call special attention to these cells, for they will be frequently referred to during this lecture.

FIG. 9.—TRANSVERSE SECTION OF OVARY OF A BARLEY FLOWER SHORTLY AFTER FERTILISATION.

Development into the future corn is in a very early stage. (Compare with Fig. 10.)

Comparatively little was known about the nature of the germination changes of the barley corn before the subject was investigated by Horace Brown and G. H. Morris in the

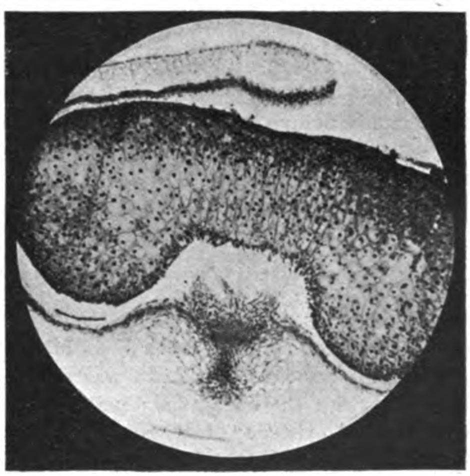

FIG. 10.—TRANSVERSE SECTION OF OVARY OF A BARLEY FLOWER AT A MORE ADVANCED STAGE OF DEVELOPMENT THAN FIG. 9.

Compare with Fig. 7, representing a transverse section of a fully-developed corn. (The section is stained and the cell-nuclei are visible as dark spots.)

year 1890.* At the time Dr. Graham delivered his course of lectures, it was recognised that the starchy part of the barley corn was the reserve food supply of the seed, and that it was utilised during the growth of the embryo; but, to judge from what one finds in Dr. Graham's lectures, little or nothing was known with regard to the ways and means by which the reserve food supply was utilised during germination. It should be remembered, however, that our modern knowledge of enzymes, or so-called soluble ferments, is more recent than Dr. Graham's lectures, and that in the absence of such knowledge it was almost impossible to obtain an insight into many of the physiological problems associated with the germinating barley corn. It is true the actions of diastase and those of some other ferments had been studied to some extent, and Dr. Graham recognised the importance of the diastatic activity of malt made

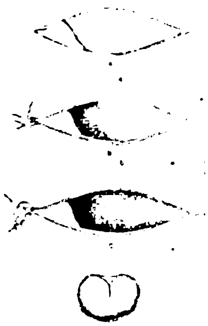

FIG. 11.—DIAGRAM SHOWING THE PROGRESS OF DISSOLUTION OF THE CELL-WALLS OF THE ENDOSPERM OF A BARLEY CORN AT DIFFERENT PERIODS DURING GERMINATION. (Disintegration of the cell-walls is indicated by shading.)

A. After three days' germination.
B. After six days' germination.
C. After ten days' germination.

(After Brown and Morris, *Journal of the Chemical Society*, 1890).

evident by starch transformation in the brewers' mashing process; but so little was Graham impressed with the knowledge then possessed regarding the existence of diastase as a specific enzyme, that he states "we are now all agreed, first, that there is no such body; and, secondly, that this [its action on starch] is not an action peculiar to diastase, even if such a body exists."

* Brown and Morris, "Researches on the Germination of the Gramineæ."—*Journal of the Chemical Society*, 1890, Vol. LVII., p. 459.

In 1890, when Brown and Morris took up the study of the germination changes of the barley corn, knowledge regarding enzymes and their actions had developed very considerably. Diastase was recognised as a specific enzyme capable of hydrolysing starch, and the existence of a considerable number of other enzymes such as invertase possessing specific actions was also well known. Moreover, it was conjectured that enzymes influenced the digestion of the food reserve of the barley corn for use of the embryo, but little or nothing was known concerning the manner in which this was effected.

In the course of Brown and Morris's investigations, it was shown that during germination of the barley corn, a progressive series of changes in the endosperm of the corn was noticeable as germination proceeds. These changes commence in the part of the endosperm nearest to the scutellum of the embryo. This part of the endosperm consists of a compressed layer of empty cell-walls of a similar constitution to the walls of the starch-containing cells (see Fig. 6). Here, immediately after germination commences, the first change is observed. These cell-walls swell and disintegrate, and partially dissolve away. Subsequently, as germination proceeds, the cell-walls of the starch-containing cells nearest to the layer of empty cells are also attacked and become disintegrated. As germination continues, this action slowly spreads through the endosperm, advancing more rapidly on the dorsal side, until in about ten days (see Fig. 11), it has modified the cell-walls throughout the whole length of the corn. As these changes proceed, the endosperm is softened and can readily be broken down by rubbing between the finger and thumb. This change constitutes the "mealiness," or "modification" which the maltster endeavours to produce in the limited germination period of malting, and is evidently induced by the disintegration of the cell-walls of the starch-containing cells liberating the starch granules contained within the cells.

Following on the disintegration of the cell-walls, the starch granules within the cells begin to show evidence of being attacked. This action commences in the starch granules which are situated nearest to the embryo and spreads through the grain, but it proceeds much more slowly than the action on the cell-walls previously described. In the ten to twelve days of germination which represents the usual length of the malting period, comparatively little of

the starch is acted on, although the walls of the starch-containing cells usually become disintegrated during this time throughout the whole length of the grain. The maltster, of course, does not wish to lose more starch from his grain than is necessary during the short period of germination which constitutes the malting process. If, on the other hand, the process of germination is allowed to proceed in an unrestricted manner, as it does during natural growth, complete solution of the starch takes place during the time taken for full development of the germ into the complete young plant.

Turning now to a consideration of the constitution of the embryo in connection with germination, physiologists had for some time regarded the so-called epithelial layer of the scutellum of the embryo—the layer of cells which forms the extreme limit of the scutellum immediately in contact with the endosperm (see Fig. 6)—as the means by which the nutritive material of the endosperm was absorbed and transferred to the growing embryo. It was obvious, in fact, that the nutritive material derived from the endosperm must pass through this layer of cells before it could be transferred to the growing embryo, for the layer is continuous over the whole surface of the scutellum. Brown and Morris, however, formed the opinion that this layer of cells possessed, not only absorptive functions, but also secretive ones; that, in fact, it was a specialised organ of secretion common to all seeds of the grass family, and one which enabled the embryo of these exceptionally constructed seeds to make use of the food reserve stored in the endosperm in a manner not previously recognised in any other class of plants.

Cytase, an enzyme which plays a conspicuous part in some of the physiological processes of plant life, is a so-called unorganised ferment which has the power of attacking and dissolving cellulose. Diastase, on the other hand, is an enzyme which attacks starch, converting it into soluble sugar. Arguing from what we have seen with regard to the changes which go on in the endosperm of the barley corn during germination, it seemed probable that the epithelial layer of the scutellum might function as a secreting organ, generating both diastase and cytase for the purpose of digesting the solid food-constituents of the endosperm, rendering them soluble and in a fit state to be absorbed as nutriment by the young embryo. If so, it might be anticipated that the solution of the cell-walls of the starch-containing cells which is observed during germination of the barley corn, would precede the action of diastase on the starch granules, for enzymes are not readily diffusible bodies, and the cell-walls of the starch-containing cells, previous to disintegration, would tend to hinder the advance of diastase.

Brown and Morris proceeded to put their conjecture to the test of experiment. I have already mentioned that the embryo and endosperm are not directly connected the one with the other; they are merely pressed one against the other, and there is no difficulty in separating the two without damage to either. These conditions make it quite easy to investigate the physiological processes of the embryo. If the embryo is carefully dissected from a barley corn it will grow under suitable conditions, apart from the endosperm, for a considerable period of time. For instance, if separated embryos are grown under conditions in which they are supplied with water only, they develop a short plumule and short rootlets at the expense of a small amount of food reserve originally present in their cells. In a brief time, however, their growth is arrested and they die of starvation. If, on the other hand, they are supplied with water containing cane-sugar, one of the most favourable carbohydrate foods for the growing germ, they develop into plants with green leaves; and if, in addition to cane-sugar, suitable nitrogenous and mineral food is also given, embryos may be reared to perfect plants by means of this "bottle" type of infant feeding. Experiments like these demonstrate that the embryo of the barley corn is enabled to grow at the expense of such carbo-hydrate and other nutriment as it obtains from the digested endosperm; but the special point Brown and Morris desired to investigate was whether the epithelial layer of the embryo was an organ capable of secreting enzymes for the purpose of digesting the endosperm. Experiments were conducted in which excised embryos placed with their scutella resting on moist barley starch were allowed to grow in this position. In every case distinct action on the starch-granules was observed. By means of these and other experiments of a somewhat similar nature, it was found that a starch-dissolving ferment was secreted by the scutellum of the embryo. Moreover, it was shown quantitatively that an increase in amount of the starch-dissolving ferment or diastase takes place as the embryo develops.

Somewhat similar experiments were also

made to ascertain if the embryo generated a cellulose-dissolving ferment during its growth. In these experiments embryos were placed with their scutella downwards on fragments of filter paper consisting of cotton fibre. After a little time the fibres of cellulose exhibited distinct evidence of solution from the action of a cellulose-dissolving ferment. These experiments were further confirmed by others, in which embryos were grown on thin sections of the endosperm of a barley corn. In these experiments it was again found that the cellulose composing the walls of the starch-containing cells of the endosperm was disintegrated by a cellulose-dissolving ferment secreted by the embryos.

But, so far, although the evidence brought forward by Brown and Morris indicated that the scutellum of the growing embryo secreted both diastase and cytase, it did not definitely locate the production of these enzymes to the particular layer of columnar epithelium cells which presents the appearance of a secreting organ (see Fig. 6 "ab ep"). This question was investigated by means of experiments with embryos from which the epithelial layer of cells was removed by dissection, an operation which can be done without serious injury to the vitality of the embryo. The results of these experiments indicated that, following removal of the epithelial layer, the embryo is incapable of secreting either diastase or cytase.

From the results of the investigations referred to, Brown and Morris arrived at the conclusion that the epithelial layer of the embryo of the barley corn and other grass seeds acted as an organ capable of secreting diastase and cytase, and that its purpose in the economy of the seed was to render the solid constituents of the endosperm soluble and capable of being absorbed by the embryo as food. The endosperm of the barley corn itself they regarded as being inert and without life; all the changes taking place in it, whether on the malting floor during restricted germination, or when the embryo develops into a fully developed plant and the endosperm is completely digested, they attributed to the action of enzymes secreted by the embryo.

Brown and Morris's investigations of the changes which take place during the germination of the barley corn was the first work to throw much light on the subject, and it constituted a marked advance in our knowledge of the scientific principles underlying the malting process; but the conclusion of these authors that the digestive changes in the endosperm originate solely in the embryo, and that the endosperm of the corn does not contribute in any way towards self-digestion, was viewed unfavourably by some botanists. Brown and Morris's conclusion indicated that seeds of the Gramineæ differ in a very marked manner from seeds of other orders of plants in the way in which they utilise their food reserve. No doubt the anatomy of the grass seed differs considerably from that of other seeds, but some botanists hesitated to accept a conclusion which differentiated the physiological processes accompanying the germination changes of the grass seed from those of other seeds in such a marked manner. Investigations in connection with this point were undertaken by various Continental botanists. Of these Haberlandt obtained results which appeared to indicate that the aleurone layer of the endosperm of the barley corn possessed the property of secreting diastase in addition to the embryo.* This conclusion, however, seemed to require confirmation, and H. Brown, in conjunction with Escombe, reinvestigated the question in 1898.†

The cells of the aleurone layer of the ripe barley corn had long been known to differ from the starch-containing cells of the endosperm in so far as they exhibit the characteristic appearances of life. The original nuclei of the starch-containing cells of the endosperm, which are very conspicuous in the early stages of the development of the corn, become disintegrated or deformed as the corn matures, and when the corn is quite ripe the appearance of the remains of the nuclei suggests complete loss of life. On the other hand, the nuc'ei of the aleurone cells of the mature corn are very well marked, and their appearance suggests that the cells are in active life. There seems to be, therefore, a marked difference in the nature of the two types of cells composing the endosperm—the starch-containing cells present the appearance of being functionless and dead, and the cells of the aleurone layer appear to be in active life. Histological evidence, therefore, seemed to support the view which had been advanced by Haberlandt that the aleurone layer might play a part in the digestive changes which take place during germination of the barley corn.

I regret that I have no time to refer other than briefly to the investigations of H. Brown and Escombe with regard to the action of the

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* Berliner deutschen botanischen Gesellschaft, 8. 40.

† *Proceedings of the Royal Society*, 1898, Vol. LXIII.

aleurone layer of the barley corn during germination. It must suffice to say that their work confirmed Haberlandt's conclusion that the aleurone layer of the endosperm functions as an organ for the secretion of diastase in addition to the epithelial layer of the embryo. Further, they were enabled to demonstrate that not only does the action of the aleurone layer resemble that of the scutellum of the embryo in secreting diastase, but it also resembles it in secreting an enzyme of the nature of cytase capable of acting on the walls of the starch-containing cells of the endosperm.

The extended investigations of Brown and Escombe, therefore, indicated that the original view of Brown and Morris regarding the germination changes of the barley corn required modification. The latter investigators considered that the digestive changes which take place in the barley endosperm during germination were occasioned by enzymes secreted by the embryo, and that the endosperm itself played no active part in these changes. It was found now that, in addition to the action which the embryo exerts in connection with the digestive changes of the endosperm, the aleurone layer of the endosperm also contributes to the production of these changes.

The evidence which has been brought forward to show, on the one hand, that the embryo of the barley corn during germination secretes diastase and cytase through the agency of the epithelial cells of the scutellum, and, on the other, that the aleurone layer of the endosperm under similar conditions also secretes similar enzymes, appears to be quite conclusive, and it is somewhat difficult to understand how any one can study the experiments on which these conclusions rest without becoming convinced of their general accuracy—nevertheless, during the past few years a growing inclination has been shown in some quarters to disregard the experimental evidence which has been brought forward in support of these statements, and to fall back on the old conception that the starch-containing cells of the endosperm of the barley corn are entirely self-digestive. The upholders of this view appear to derive some support from the investigations of the Continental workers, Puriewitsch, Grüss, and Bruschi, but I must confess that I can find nothing in the work of these investigators which materially affects the experimental evidence brought forward by Brown and Morris, Haberlandt, and Brown and Escombe. It may be a question open to doubt whether the starch-containing cells of the endosperm of the ripe barley corn are dead, or whether they still retain traces of vitality sufficient to influence to some slight extent the changes which proceed during germination. But I fail to find any evidence in the work of Puriewitsch, or the other Continental investigators named, which seriously questions the view that the embryo and the aleurone layer of the endosperm play a leading part in the digestive changes of the germinating barley corn. The subject is, however, one of much importance, not only from a botanical point of view, but also in connection with technical malting, and it is most desirable that doubt of any kind in connection with it should be removed. I am pleased to say, therefore, that recently some very interesting investigations* have been carried on in connection with the question by Dr. F. Stoward, an old student and fellow worker in my laboratory, which throw a good deal of light on the enzyme-secreting properties evidenced by different parts of the barley corn. The main object of Stoward's investigations has been to ascertain definitely whether the enzyme-secreting powers of the embryo, and of the aleurone layer of the barley corn, are mainly responsible for the digestion of the food reserve during germination, as is contended by H. Brown and Escombe, or whether the starch-containing cells of the endosperm are self-digestive, according to the views of Bruschi and others.

It was imperative, in order to make any real advance on the investigations which had already been carried out in connection with these questions, to attack the problem quantitatively, for measures of the amounts of enzymes secreted by particular parts of the germinating corn must be obtained before any definite conclusion can be formed regarding the influence exerted by these different parts during germination. Stoward commenced his study by determining the relative amounts of diastase secreted by the embryo alone, by the aleurone layer alone, and by the starch-containing cells of the endosperm.

The experiments by which these determinations were made had to be carried out under conditions of exceptional difficulty. Not only was it necessary for portions of the barley corn such as the embryo, or the aleurone layer, employed in the experiments to be kept alive and in a healthy condition during periods of perhaps several weeks in order to study

* These investigations will shortly be described in the *Annals of Botany*.

their actions, but the experiments throughout their course had to be conducted under perfectly sterile conditions. I should like to describe the manner in which these experimental difficulties were met, but a detailed account of Stoward's work would be out of place here. It must suffice to give the conclusions Stoward has arrived at from the results of his investigations. These may be briefly summarised as follows:—

The original conclusion of Brown and Morris that the embryo during germination secretes diastase and cytase in comparatively large quantities is fully confirmed, as is, also, the conclusion of Brown and Escombe that the aleurone cells of the endosperm secrete similar enzymes. Probably the part played by the aleurone cells in the digestive changes during germination is somewhat greater than that of the embryo, but the combined actions of the aleurone cells and the embryo are sufficient to account for the whole of the observed changes. When the starch-containing portion of the endosperm, apart from the aleurone layer and the embryo, is placed under conditions favourable to self-digestion, but little action is observed even after several weeks, and the character of the feeble action which proceeds may be traced to the influence of residual enzymes pre-existing in the starch-containing cells of the endosperm. No evidence was found which tended to show that the starch-containing cells are capable of secreting digestive enzymes.

I mentioned before, when referring to H. Brown and Morris's original view that germination changes in the barley corn were effected solely by the embryo, that some botanists were reluctant to accept this view, because it dissociated the seeds of the Gramineæ in a very marked manner from the seeds of all other plants. But when it is recognised that the aleurone layer of the barley corn, itself a portion of the endosperm, takes part in the germination changes of the corn, the botanical difficulty vanishes. The grass seed need no longer be regarded as differing essentially from other seeds—it is merely a highly specialised seed. The aleurone layer is a portion of the endosperm which seems to have become differentiated for the purpose of secreting enzymes required for the digestion of the food reserves of the seed. The secretory epithelium of the embryo also appears to have become specialised as an organ for secreting similar digestive enzymes. The starchy part of the endosperm seems to have lost the property of self-digestion, but this loss is amply compensated by the digestive activity of the aleurone layer and the embryo.

So far, when speaking of the changes which take place in the barley corn during germination, I have only referred to the breaking down of the carbo-hydrate constituents of the endosperm—to the conversion of the food reserve of starch and cellulose into soluble diffusible carbohydrate material capable of assimilation by the growing embryo. It must not be forgotten, however, that conversion of the reserve protein matter stored in the endosperm also takes place during germination of the barley corn through the instrumentality of one or more proteolytic enzymes. The growing embryo requires nitrogenous food, and we know that transference of nitrogen-containing matter from the endosperm to the embryo is a marked feature of germination. For example, instances will be found in the following table* which illustrate how the nitrogen originally present in the endosperm of the barley corn migrates to the embryo at various stages of the malting process.

	Hungarian Barley.		Chevalier.	
	Per cent. N. left in endosperms.	Per cent. N. which has migrated to embryo.	Per cent. N. left in endosperms.	Per cent. N. which has migrated to embryo.
After steeping	100	—	100	—
Three days on floor	91·1	8·9	86·2	13·8
Five days on floor	82·8	17·2	83·0	17·0
Seven days on floor	71·2	28·8	82·8	17·2
Nine days on floor	64·6	35·4	67·8	32·2

* *Transactions of the Guinness Research Laboratory*, Vol. I., Part II., 286.

It will be seen that about thirty-five per cent. of the endosperm nitrogen passes into the growing embryo during nine days' germination on the malting floors.

The work of Weiss,* and that of other investigators, tends to show that the proteolytic action which takes place during germination probably results from the actions of two distinct enzymes, one of the nature of a peptase and the other of a tryptase. But notwithstanding the considerable amount of work done in connection with the proteolytic enzymes present in the germinating barley corn, we are still very much in the dark as to the manner and place of their origin in the corn. We have seen that the embryo and the aleurone layer of the grain secrete cytase and diastase, and by analogy one would be inclined to look to the same parts of the corn as the probable source of the proteolytic enzymes, but at present direct evidence in support of this view is wanting. The question is one of many connected with the biological processes of the germinating barley corn which still await elucidation.

Among the points of difference which distinguish the highly specialised seeds of the Gramineæ from other seeds is one associated with the solution of the endosperm-constituents during germination which deserves special attention, as it is of considerable importance from both the scientific and technical points of view.

During the germination changes in an ordinary seed, solution of the food reserve and transference of the food to the growing embryo is the direct work of living cells, and the actions throughout their whole course are, so to speak, under the rule and protection of living protoplasm. But in the germinating grass seed a different condition of things is noticeable, more especially in the later stages of germination. We have seen in the case of the germinating barley corn that the insoluble starch and protein matter of the endosperm are converted into soluble diffusible constituents capable of being absorbed by the embryo as food. The embryo, however, does not assimilate this food as rapidly as it is produced, and it accumulates to some extent in the cavity of the endosperm enclosed by the seed coverings. Now, under these conditions there must be opportunity for loss of some of the accumulated food products by diffusion through the seed coverings, unless the seed is specially provided with means to prevent it—for material such as sugar, which constitutes the bulk of the dissolved food products, usually diffuses readily through thin cellular membranes such as the coverings of the barley corn. Under these conditions it is a matter of peculiar interest to find that the testa, or inner thin skin of the barley corn, behaves in quite an abnormal manner with regard to diffusion—in fact, it constitutes the most remarkable "semi-permeable membrane" at present known. Not only does it obstruct diffusion of such bodies as sugar and other soluble food products present in the germinating corn—thus rendering it an efficient protection for the food supply of the embryo—but it also acts as a semi-permeable membrane with regard to such highly diffusible bodies as sulphuric acid, hydrochloric acid, and very many mineral salts when in aqueous solution.

I pointed out a short time ago,* when calling attention to the remarkable property of semi-permeability possessed by the seed-coverings of the barley corn, that hitherto it had been supposed that among naturally-formed membranes the property of semi-permeability was confined to those composed of living protoplasm, and was absent from non-living structures such as the coverings of the barley corn; but in these coverings we now find evidence of the most marked semi-permeability. For instance, if dry barley corns are immersed in a 5 per cent. solution of sulphuric acid, the water alone of the solution is absorbed by the grain, the acid outside being increased in concentration in a manner proportional to the water absorbed by the barley corns. Nor is this so in the case of a 5 per cent. solution of acid only. With solutions of varying strengths of acid up to 36 per cent. a result is obtained which is similar in kind but different in degree, for as the acid solution becomes more concentrated, less water enters the seed. This difference is to be ascribed to the higher osmotic pressure of the stronger solutions. In short, a seed of barley behaves as a cell completely enclosed in a semi-permeable membrane, this membrane being the testa, or inner skin of the corn.

This property of semi-permeability is found to extend to the testa, or inner seed-coverings, of all the species of Gramineæ yet examined, and it appears reasonable to suppose that its special value to the seed is to protect the food-supply of the embryo, which would otherwise be open to loss owing to the highly-specialised nature of the seeds of the grass family.

It is interesting to note also, in connection

* Meddel. Carlsberg Laboratoriet, 1903.

* *Annals of Botany*, 1907, Vol. XXI., p. 79.

with this unique semi-permeable covering of the barley corn and other grass seeds, that nature appears to have made special arrangements in shaping the seed to protect the covering from rupture, which would, of course, destroy its efficiency. When the dry barley corn absorbs water previous to germination, it swells to the extent of about 50 per cent. of its original volume, but danger of rupture of the coverings is avoided by the re-entering ventral furrow which characterises the corn. This furrow, it will be noticed (see Fig. 12) permits very considerable expansion of the contents of the grain without endangering the continuity of its coverings; it acts as a sort of expansion safety-valve.

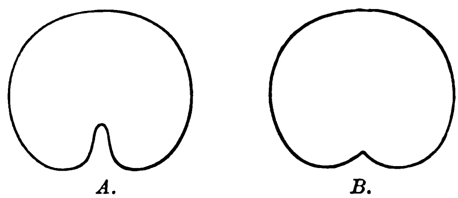

Fig. 12.—Diagram of Transverse Sections of Dry and Steeped Barley Corns.

A. Dry corn.
B. Steeped corn.

But the unique and hitherto unsuspected semi-permeable nature of the inner skin of the barley corn just referred to, is even less remarkable than one which came to light in the course of further investigations.* These revealed the power of selective permeability of the skin in the presence of certain solutes. Thus, if barley corns are immersed in a mixture of solutions of mercuric chloride and sulphuric acid, the former salt passes through the seed-coverings and diffuses throughout the whole seed, while the sulphuric acid is kept outside. In a similar fashion, acetic acid and the fatty acids generally are able to pass through the seed-coverings; but the salts of these acids, such as sodium acetate, are excluded. More remarkable still is the fact that whereas acetic acid enters and diffuses through the seed very readily, the corresponding amino-acid, glycine, will not enter at all. Aqueous solution of ethyl alcohol, aldehyde, acetone, and ethylic acetate diffuse into the seed rapidly; but in the anhydrous state these liquids are excluded. The only explanation of this property of selective-permeability which can be suggested at present is that it is related in some way to the manner in which the molecules of the various solutes are united with the molecules of the solvent water. The subject is a very promising field for further investigation.

In this lecture I have been able to refer to a few only of many subjects of scientific interest associated with the malting process, but I think I have said enough to indicate what wide fields for future investigation still lie open in this direction. Probably the germination changes of the barley corn have been studied more thoroughly that those of any other seed, and yet we appear to have only just penetrated the fringe of the subject at present. Much more knowledge is required before malting is placed on a thoroughly sound scientific basis.

* *Proceedings of the Royal Society*, B., 1909, Vols. LXXXI. and LXXXII.

COMMERCE AND THE UNIVERSITIES.*

INDUSTRIAL FELLOWSHIPS.

The publication by the Royal Commission for the Exhibition of 1851 of a scheme for the award of industrial bursaries to young men who, after a course of training in a university or approved technical college, desire to enter engineering, chemical, or other manufacturing works, is another indication of the desire of educationists to establish a link between education and industry. This scheme is based on the assumption that college-trained men are not able as a rule to obtain remunerative employment in industries immediately after the completion of their college course. Its main characteristic, however, is to lead the students to the manufacturers. The contrary movement, to bring the manufacturers to the universities, presents an equally important problem, which in a large measure remains unsolved in this country, and a complementary scheme which would encourage this movement is much needed.

Such a scheme is in operation in the University of Kansas, under the enlightened direction of the Professor of Industrial Chemistry, Robert Kennedy Duncan.† A reference was made to the scheme in the evidence of Dr. Nicholas Murray Butler, President of Columbia University, New York, before the Royal Commission on University Education in London, but so far as is known details have not been published on this side of the Atlantic. The recognition of the need for a thorough general training in science before a student is allowed to specialise in applied science, is an extremely important characteristic of Professor Duncan's scheme. He decided, without hesitation or reservation, that the scheme should only apply to highly-trained university graduates.

* Reprinted, by permission of the Editor, from the *Times*.

† Professor Duncan is a member of the Royal Society of Arts.

The conditions of American manufacture were favourable to the establishment of the scheme. Writing in the *American Journal of Industrial and Engineering Chemistry* for August, 1909, Professor Duncan says:—

"Two years ago . . . conditions were changing rapidly. The unexampled and wasteful production of the country was bidding fair to result in over-production; in the practice of business intrigue no manufacturer had anything to learn from another; the wealth of raw material had in a large measure been aggregated into the holdings of a few men who would release them only at an onerous and distressful rate; the tariff, high as it was, was unable to exclude many articles made under scientific supervision, and the tariff itself lay and lies in increasingly unstable equilibrium. These facts convinced me that American manufacture was approaching a crisis, and that there would soon be a realisation that safety in manufacture could be gained only through efficiency."

In what way was this efficiency to be achieved? The American manufacturer—and the same may no doubt be said of the British manufacturer—is generally incapable of organising an efficient research department in his own works. He lacks the knowledge and experience necessary for the work; he cannot judge the qualifications of the men he should employ; he cannot estimate the expenditure necessary for the work; and, lastly and chiefly, he does not know how to treat the man of science by giving him power and trust.

The Kansas University Scheme.

With these facts before him, Professor Duncan devised in 1907 his scheme of Industrial Fellowships. The Fellowships are tenable in the Chemical Department of the University of Kansas by students appointed by the university, and the emoluments are provided by manufacturers. To illustrate the conditions under which the Fellowships are held, those attaching to a Fellowship (No. 7) established by a glass company may be taken as typical. The object of the Fellowship was investigation into the optical properties of glass in relation to its chemical constitution. The Fellow, who was appointed by the university, contracted to devote the whole of his time to this investigation, with the exception of three hours a week, which he gave to teaching in the university, in return for which he was exempted from the payment of university fees. The tenure of the Fellowship was for two years, and the emoluments, $1,500 a year, were provided by the company. The essential characteristics of the scheme remain to be mentioned. All discoveries made by the Fellow during the tenure of the Fellowship become the property of the company, subject to the payment of 10 per cent. of the net profits to the Fellow; and any patents taken out by the Fellow are assigned to the company. The Fellow is allowed to publish any results, the publication of which, in the opinion of the company, would not injure their interests. At the end of the tenure the Fellow is required to present to the university a complete monograph on the work done, and, after the expiration of three years, the university is at liberty to publish the results for the use and benefit of the people.

It will be seen that by this ingenious arrangement the interests of all parties are safeguarded. To the university the influence of the Fellows and their teaching work are valuable assets, while its character as a public institution is protected by the right to publish the results of researches conducted within its walls after the lapse of three years. The Fellow carries on his work under greater advantages than are possible in a factory. He can consult the university professors, specialists in all departments of knowledge, in any difficulties that may arise, and he has the stimulus of working alongside others with similar objects; the resources of libraries and museums are placed unreservedly at his disposal; he has the opportunity of carrying out his laboratory experiments under factory conditions in the donor's works; and he becomes an expert in his particular study, with excellent prospects of remunerative employment in the factory of the company or elsewhere. Lastly, the conditions have proved to be satisfactory to the manufacturer.

Results Attained.

Some particulars may now be given of the researches which have been carried out under this scheme. The general conditions attaching to the Fellowships have in all cases been identical, though the emoluments have varied. The following is a list of the subjects investigated by the first ten Fellows appointed:—

1. The chemistry of laundering.
2. A search for a new diastase (otherwise, an attempt to make a new fodder on scientific principles).
3. An attempt to utilise the constituents of waste buttermilk.
4. The chemistry of baking. (This Fellowship was established by the National Association of Master Bakers.)
5. The constituents of crude petroleum.
6. The enamelling of steel tanks for chemical operations on a large scale.
7. Optical properties of glass.
8. New utilities for Portland cement and improvements in its manufacture.
9. Certain glands of deep-sea mammals.
10. New utilities for ozone.

From the details which have been given of the conditions attaching to the Fellowships it will be understood that information cannot, in all cases, be given as to the results achieved by the researches. It is significant, however, that Fellowship No. 1 was continued for a further period at double the value, with an offer from the donors either to take the Fellow into their factory or to continue the Fellowship with increased emoluments. The second Fellowship was continued for a third year.

This Fellow discovered a method by which the high diastatic content of alfalfa could be conserved in fodder. Fellow No. 3 discovered a method of utilising stale bread in the manufacture of new bread, and a method of standardizing the manufacture of salt-rising bread.

Provided the co-operation of manufacturers could be obtained, there is no apparent reason why a scheme based on the same principles could not be successfully worked in this country.

ARTS AND CRAFTS.

The Report on the Royal College of Art. — The most interesting artistic event of the month is the publication of the Report of the Departmental Committee on the Royal College of Art. The main recommendations of the committee have been published in the daily papers, and by now most people interested are familiar with them. They show throughout a desire to co-ordinate the art teaching of the country with its most important industries, and to encourage design for manufacturing processes more than has been done in the past. Shortly, they suggest that the Royal College of Art shall in the future be looked upon as a post-graduate college, whose students will be recruited from the schools of art in the great provincial manufacturing centres; and that liberal provision should be made for scholarships tenable at these provincial colleges. By this arrangement we should get the ordinary art schools, which would send the best of their pupils on to the provincial colleges, which would in their turn send on their cleverest students to the Royal College.

As one reads the report, one cannot but be struck by the good sense and moderation of the document, and the evident desire of the members of the committee to place the teaching of design (it is with design that the report is mainly occupied) on a satisfactory and common-sense basis. They are evidently well aware that the present system (or want of system) of training designers for manufacturing processes leaves much to be desired, and they have done their utmost to suggest lines on which it can be bettered. Their suggestions are sane and practical, and in most respects admirable, but there come points where they betray the fact that among the eight members who sign the report (though there are two who are, amongst other things, designers) there is not one whose primary business in life is designing for manufacture.

If the recommendations of the committee are carried out they should revolutionise the whole system of design teaching in this country, and in many ways to very good purpose. There are, however, points which cause one to fear that in making the teaching of design severely practical, art may be rather ousted by commercialism. It is true, of course, that of late, in what should be schools of industrial art, we have heard too much about art and not enough about industry, but it is possible to go too far on the other side. *Apropos* of the training of teachers, a good deal is said in the report about the weakness of students in literary attainments, and suggestions are made towards remedying it. Nothing is said about the literary education of the designer. And, in a way, that is to the good. There is certainly no reason why in order to be a good designer a man should have passed, or be able to pass, say, the Oxford or Cambridge Local Examinations. But, on the other hand, it is necessary that he should be in some sense a man of education. It is partly because they are not that, that many men, who up to a certain point are competent designers, fail to do really first-class work.

Again, the report speaks of the advisability of students at the end of their career spending time in studying at the Victoria and Albert Museum and elsewhere, but it seems to contemplate this merely for the select few who are qualified to undertake a post-graduate course, and for them at the extreme end of their training. Now, if the majority of design students were men and women of thoroughly sound general education, brought up in highly-cultured homes or amongst surroundings which encouraged their powers of artistic perception, that might be all very well. But, as the report itself shows, they are not. If you take a very imperfectly educated boy of the artisan or lower middle class, and turn him into the local art school, to be taught (as the report again suggests is probable) by an art master whose own general education is defective; if at the end of a couple of years you transfer that youth to a provincial college, where he will specialise in design for some manufacture, under art masters with whom are associated representative manufacturers and artisans connected with that industry; you may possibly make him by the end of his time a good hack designer. But can you reasonably expect him to be a man of such strong and well-trained artistic taste that he can and will, in spite of the many difficulties which beset a trade designer, persistently and successfully do the best kind of work? There would surely be more chance of that if at an earlier stage in his career, before he had been thoroughly drilled in trade requirements, he could be turned into the Victoria and Albert Museum for a few months with a judicious guide, and shown at first, and then encouraged to see for himself, what the best men have done before him. Some of our big manufacturing towns, have, it is true, good museums, others have not. And no local museum *plus* a system of circulation, however good, can reproduce in the provinces the Victoria and Albert Museum. In that we have, undoubtedly, the greatest and most comprehensive storehouse of industrial art to be found in Europe—a storehouse of which it may be truly said that a real and intelligent knowledge of its contents would be a liberal education of just the kind of which a man who is to be a trade designer stands in need. Since we have the Museum, it is surely poor

economy not to use it to the full, and to regard it as a luxury for a few designers rather than as a necessity for all. It is to be hoped that the fact that the Royal College of Art has been conspicuously out of touch with industrial design will not blind those concerned with the training of the coming generation of designers to the fact that nothing better could be done for students, once they are competent draughtsmen, than to let them work at the Museum for a while.

National Competition.—A rather pathetic interest attaches to this year's National Competition Exhibition, for, though it is not the last of its race, it is the last but one that will be seen at South Kensington. Whatever may take the place of the existing regulations with regard to National Competition, the old system has received its death blow and, in consequence, this year's exhibition has lost a good deal of its importance. It does, indeed, show what is going on in the principal art schools throughout the country, but it cannot give as much indication as usual of what will be done in future years. There is no denying that the awards and the works shown at one year's exhibition have always exercised a very strong influence on the work of succeeding sessions—not, it is to be feared, entirely because the decisions given were looked upon as the best that could possibly have been made, but in large measure because students hoped to gather from them the kind of work which was likely to meet with success. It is just worth noting, in passing, that this little proceeding did not always turn out very satisfactorily, as the more wary of the examiners sometimes realised just what was happening. But, whatever may have been the exact causes of the influence of the National Competition Exhibition, it is plain that, for the next year or so, while the future of the exhibition itself is doubtful and the work of reconstructing the examination system of the Board of Education goes forward, the influence itself will be felt but slightly, even if it is not wholly inoperative. It remains, therefore, rather to see what this year's exhibition tells us of the actual state of design teaching than to point out what the present tendencies seem to foretell. There are two points about this year's work which may be noted with a good deal of satisfaction—the number and excellence of the studies of historic styles of ornament, and the decorative quality and the understanding of the requirements of design shown by a good deal of the work sent in, not only under the headings of "Designs Based on the Flowering Plant" and "Plant and Three Designs," but also of "Studies of Plant Form." If students can only be brought to realise the importance of studying both plant form and ancient ornament, the less brilliant of them will be on the road towards producing passable designs, and the really clever designers will have that grounding which it is necessary to acquire if they wish their own inherent powers to develop later to the full extent of their capacity. There is just one caution, however, which must be added: study both of old work and of nature is good, but it must be combined with the appreciation of methods of workmanship. It may seem almost unnecessary to say that nowadays, but one of the best, if not the best of the sets of designs based on a flowering plant, made no mention of what the designs were for—nor did the patterns themselves make it plain. The students as a whole, however, show in their studies, whether made from nature or from old work, a far better appreciation of the kind of drawings which will be useful to a practical designer than they did a few years ago.

When we turn to actual designs, a noticeable feature this year, as last, is the number of fairly simple practical patterns coming, for the most part, from the great manufacturing centres which have obtained small awards. Stencilled hangings seem rather to have taken the place of the printed muslins so popular some years ago, and to have attracted, like them, somewhat disproportionately high awards. In some of the crafts the standard is distinctly higher than it used to be. The best of the gold and silver work is accomplished craftsmanship, and, though the awards for bookbinding are not so high as they have sometimes been, and the designs are as a whole somewhat lacking in ingenuity, the workmanship is usually very good. The lettering, too, is as a whole very satisfactory, more especially the bold work on a large scale, but there is not so much script as in previous years, and some of the illumination is unnecessarily hard and archaic. Among interesting exhibits which do not fall into any well defined class, may be mentioned the delicately tinted vellum caskets and boxes from Armstrong College, Newcastle, and the really beautiful embossed leatherwork from Birmingham (Margaret Street).

EMPIRE NOTES.

A Congress of Empire Universities.—It is proposed to hold a congress of representatives of all the universities of the British Empire, in London next year, for the purpose of considering the question of organisation, the relationship of the universities to teachers, undergraduate students and schools, and other subjects of academic interest. The secretary of the Congress is Dr. R. D. Roberts, the Registrar of the University Extension Board of London, and an influential committee has been appointed to make the necessary arrangements, with Prince Arthur of Connaught as president. Dr. Roberts has just returned from Canada, where, at a conference called for the purpose, the programme of the London Congress was discussed. Nineteen universities, says Dr. Roberts, were represented at the conference. He found that the most interesting feature of the conference was the opportunity it afforded for the discussion of matters of purely

local concern, upon which the views of the universities, as a whole, had never been focussed before. The result, he considers, is almost certain to be the establishment of local conferences, a fact which he had come to realise in connection with the meetings of the Home Congress Committee. This committee, which consists of the vice-chancellors and other representatives of the home universities will, he evidently thinks, be the means of bringing these universities into closer relationship with each other, while the proposed Congress will widen the interest taken in higher educational, and particularly university, movements, to the advantage of the whole Empire.

The Mixture of Races.—The recent Universal Races Congress held in London, which, as an assembly, was like Joseph's coat of many colours, had under discussion the miscegenation of the races, a subject which naturally evoked many differences of opinion. What British South Africa thinks about that question may be judged from the decision of the Supreme Court of Cape Colony, in connection with a case brought before it during the last few weeks. It appears that the children of a European, who had married a coloured woman, were admitted to a public school in the district of Gordonia. To this proceeding objections were raised by the parents of the European children attending the school. The school committee, therefore, refused to allow the further attendance of the coloured children. The matter was thereupon submitted to the Supreme Court, on the general question of the rights of coloured children to attend the public schools of the State. The presiding judge refused to compel the school committee to readmit the children, and his decision was upheld by the full bench. This case, therefore, will decide the question as to the exclusion of the children of mixed marriages from the State schools, a question which has been for some time under consideration, as attempts have frequently been made, in some instances with success, to secure the admission of children of coloured or mixed parentage to schools reserved for the children of European parents. Provision has been made for coloured children in separate public elementary schools, and to this provision the authorities evidently intend to adhere.

The Development of the Katanga.—A Consular report has just been issued by the Board of Trade on the Katanga. It is most informative, and gives many interesting facts and figures relative to the industrial and commercial development of this comparatively little known region of Southern Africa. The Katanga, as its name implies, is a copper country, and some of the native mines have been working for centuries. The entire territory appears to be mineralised, and the fluxes for smelting are found almost side by side with the metals. At some of the new locations, the ore bodies are of enormous size. Gold and tin are being profitably worked in various parts, while diamond pipes are known to exist on the Kundelunga River. The soil of the river valleys is rich and fertile, and capable of producing almost anything. These valleys should lend themselves to culture of every description, in addition to maize, which yields a large return and for which the market is unlimited, fruit farming, tobacco growing, cotton and coffee planting, should prove profitable undertakings. Both cotton and tobacco are indigenous, and are cultivated by the natives on a small scale. Pig raising is possible everywhere. Lucerne would yield three crops per annum. Oats would probably do well, and wheat has been successfully grown in one or two instances. There is said to be an opening for fibre plantations, for fibre is found everywhere on ant-hills, which are a distinctive feature of the landscape. Outside the mining camps native labour is plentiful and cheap. It is computed that the money already invested in various operations is not less than £10,000,000. With regard to imports, although the statistics are incomplete, the United Kingdom is known to lead the way, while South Africa last year supplied goods to the value of £268,022, of which the greater part must have gone from England. It is roughly calculated that 70 per cent. of the general merchandise is obtained from one part or another of the British Empire; a fact that shows an excellent beginning has been made.

The Cultivation of Cotton in the Transvaal.—The development of the cotton-growing industry in the Transvaal has recently been making excellent progress. For some time past experts have been endeavouring to induce farmers, whose properties are situated in that part of the country where the soil and climate are such as will give the plant a fair trial, to make tests. Many farmers who have made these tests have been convinced that good crops are to be obtained from their land, and that this branch may possibly be made a profitable adjunct to their general farming operations. The efforts of the Government experimentalists have been attended with striking results. A comparison between American-grown cotton and some from the Rustenburg experimental station shows that one variety (Bancroft) at least is well up to the mark. The American yield test gives forty-eight bolls of seed cotton to the pound, whereas that grown at Rustenburg yielded forty-three bolls to the pound. This is regarded by Manchester experts as eminently satisfactory, the more so when viewed in the light of the productions of former years. The question that is vexing the promoters of extensive cotton cultivation is not so much whether the cotton equals the American standard, but whether it can be made a commercial success. As to this, there appears to be a wide difference of opinion. It is asserted in some quarters that the demand for no other article is so far in excess of the supply as is the case with cotton. If this be true, it seems only reasonable to assume that if the cotton can be produced in sufficiently large quantities, a great

industry will be built up in South Africa in time to come. On the other hand it must be borne in mind that the United States of America has an established market for the product. Inquiries are being prosecuted into the cost of the various items which add to the price of the article from the time it leaves the grower till it reaches its market, such as railway rates, wharf dues, freight charges, brokerage, sellers' commission, and so forth. Until these facts are elicited, it will be impossible to arrive at anything definite as to the net profit that can reasonably be expected by the grower.

Natal Spas.—The hot springs of New Zealand have a wide reputation, but Natal has recently shown that springs of a similar nature are to be found within her borders. Not long ago springs were discovered rising from an island in the Tugela River. Now sulphur springs have been located near Greytown. The latter cannot be regarded as a new discovery, since many years ago they were known to exist by the Dutch community in Natal. The waters have been proved to contain similar chemical constituents to those of Harrogate and other popular European spas. The supply is plentiful, and issues from the rocks at the rate of some thousands of gallons per hour. As the climate of Natal possesses much to attract those whose health requires these healing waters, and having regard to the proximity to Europe, it is hoped in South Africa that Greytown will eventually become one of the largest and most prosperous resorts in the world.

Railway Progress in Western Australia.—The Premier of Western Australia, the Hon. Frank Wilson, C.M.G., who has just returned from his Coronation visit to this country, in a speech delivered a few days ago, stated that the earnings of the State railways of Western Australia for the financial year ending June 30th last, showed an increase of £207,085 over the previous year, the net profit for the year being £224,441. The new railways, opened during the past twelve months, to the goldfields and the agricultural districts, amount to 231 miles, while nine additional lines, representing 354 miles, had been completed, or nearly completed. The total railway mileage opened to January last was 2,384 miles. When all the lines now in course of construction and survey are finished there will be a total of 3,220 miles. The successful operation and development of the State railways by Australia, under the careful and economical management now employed in all the different States, furnish the advocates of the nationalisation of home railways with excellent arguments which have recently been advanced on account of the troubles in the railway world through which the country has just passed. The conditions, however, which obtain in new countries like Australia and New Zealand are so different from those of the old country that the cases are scarcely parallel. At the same time it is useful to note that State ownership, as at present illustrated in the progress and evident prosperity of the railways of our southern Dominions, is proving a distinct advantage to the communities they serve.

Canadian Dividends for British Shareholders.—Attention has been drawn in these columns to the opportunities for the investment of British capital in Canadian undertakings. It has also been pointed out that British investors have a larger interest in Dominion securities than Canadians and Americans. In view of this it is interesting to note some figures given in a recent issue of the *Monetary Times* of Toronto, which indicate the amount paid in dividends to British investors as compared with that paid in the Dominion itself. It appears that £695,750 crossed the Atlantic after July 1st of this year, this being six months' interest on Dominion securities. At the same time the amount paid in Canada for the same period was approximately £8,000. The United States of America have but a small share in the total amount paid. These figures demonstrate the faith held by the people of these islands in the future of the Dominion. The bond issues of the Western Provincial municipalities, which offer a comparatively low return, are exceedingly popular, and of these British investors have absorbed 65 per cent., against 1 per cent. taken up in the United States and 34 per cent. in Canada.

CORRESPONDENCE.

TOBACCO, COTTON, AND CASTOR OIL CULTURE IN SOUTH AFRICA.

I have received a copy of the *Journal of the Royal Society of Arts* of March 13th, 1896, containing an article by Mr. C. Tripp on the cultivation of tobacco in Sumatra, which proves most interesting and instructive, and contains invaluable information.

Unhappily, our Government does not sufficiently encourage farmers to depart from their old-fashioned ways of agriculture, nor is instilled into them the spirit of venture into new methods of farming to move with the times. This by no means implies that the Government must spoon-feed the agricultural community, but it might to advantage impart knowledge by means of lectures and practical proof, and so educate a most conservative people, slow to depart from the ways of their forefathers.

A few years since, tobacco culture in the Transvaal and in the Orange Free State appealed to me, and I decided to experiment locally. I gathered advice as to the suitability of certain soil on the Sunday River, and of the climate, and the difficulty of securing skilled labour was eventually overcome. The size of the plants and of the leaves, and the quality of the tobacco, proved highly satisfactory, and the aroma and flavour were excellent.

The following year I extended operations to prove the profits of tobacco culture, with the result that the demand for the local-grown tobacco exceeded far the supply. Many farmers came to view the fields, and a number of them are planting this season, which is encouraging. I am now experimenting with Turkish cigar variety and Brazilian tobaccos. Unfortunately, however, skilled labour is wanting, which is proving a drawback and hardship. Fermentation and the curing of the leaves are imperfectly understood, and our workmen cannot grasp that successful culture lies in such apparently small matters as weeding and in the keeping of the soil loose, topping carefully and systematically, and in the gathering of the leaves separately (and ripe leaves only), and carefully conveying them to the drying sheds.

Cotton Culture.—Last year I planted the following kinds of cotton—Barbadoes, St. Vincent, Egyptian Abbassi, and American Rattler. The plants grew well and the bolls, with a fine fibre lint, were large and well developed. Cotton cultivation should be encouraged, and it is pleasing to find that the East London Chamber of Commerce is taking the matter in hand.

Castor Oil.—On the mines and elsewhere in the Union there is practically an unlimited demand for castor oil. To experiment with the cultivation of the castor bean followed naturally, and I planted the Italian and the colonial kinds. Both grew well and yielded beyond expectations. Under irrigation I feel sure nothing more profitable can be cultivated, but as such lands are limited and largely required for lucerne and cereal cultivation, I experimented under conditions approaching those of dry lands with satisfactory results. If dry, the first season might prove trying, but even under adverse conditions, its cultivation will pay from the first year; and as the castor plant or tree is perennial, unless too much exposed the first year or two to frost, I most strenuously advocate its cultivation on dry lands, that is, ground lying idle and useless at present, of which there are millions of acres. I also planted a variety which attains a height of upwards of ten feet with wide-spreading branches, strong enough to support a man's weight. It is, therefore, not difficult to grasp the rich harvest obtainable therefrom. Still our farmers shrug their shoulders and smile when urged to grow the castor bean. Yet ere very many more years have passed the castor bean, like lucerne, against which farmers exhibited bitter dislike, will be grown extensively, and prove a profitable branch of South African agriculture.

P. J. FOURIE.

Jansenville, August 5th, 1911.

GENERAL NOTES.

THE IMPORT TRADE OF MONASTIR.—The Italian Consul at Monastir, in a report to the Minister of Foreign Affairs at Rome, states that the value of the imports to that district during 1910 amounted to 9,091,300 francs (£363,652), of which other parts of Turkey contributed more than half, viz., to the value of 4,960,800 francs; Austria, 1,089,300 francs; Germany, 519,700 francs; Belgium, 508,000 francs; Great Britain, 466,000 francs, whilst the imports from Italy only amounted to 151,000 francs (£6,140) in value, or about one-sixtieth. The report, whilst showing that the imports are increasing, points out that manufacturers would do well to put themselves in direct communication with the local traders by sending out representatives. The present time is especially favourable for military outfitters, as Monastir is shortly to become the headquarters of an army corps. Italian flour of ordinary quality finds a ready market, and there is an increasing demand for Italian "Vermouth," "Fernet," and other liqueurs. The sale of chocolate might be considerably increased by judicious advertising. Knitted goods and hosiery, both cotton and wool, find a ready sale throughout the district, whilst chemical and pharmaceutical products are in demand. Amongst other goods may be mentioned leather, ready-made boots and shoes of medium quality, rope and twine, packing paper, earthenware and majolica of ordinary quality, thread and sewing-cotton on reel, cotton goods of every description, "cretonnes," flannels, etc.

COMMERCE OF ITALY.—During the first six months of the present year the total value of the foreign trade of Italy, as compared with that of the corresponding period last year, was as follows:—

	1910.—Lire.	1911.—Lire.	Increase.
Imports . . .	1,594,221,640	1,798,128,596	203,906,956
Exports . . .	1,009,316,418	1,029,722,794	20,406,376
	2,603,538,058	2,827,851,390	224,313,332
or £ sterling .	104,141,522	113,114,055	8,972,533

MEGASS AND BAMBOO PAPER IN TRINIDAD.—After much experimenting in Trinidad it is claimed that paper from megass (sugar-cane refuse) has been successfully manufactured, and that with further possible development the refuse of the cane, now used only for fuel, may be used in connection with bamboo fibre in the manufacture of a paper which, in quality and price, can command the market against any wood-paper now thereon. The quality of the fibre is obtained by combining the two fibres. Neither the cane-fibre nor that of the bamboo, used alone, will produce this paper. The proper combination of the two under conditions in which the experiments have been carried on, will alone give the desired result. The fibre of the bamboo is long and coarse, while that of the cane is short and soft, and in their combination the happy medium is said to have been found. It is said that no chemicals have been used in making the paper, and the difference in colour is produced by the addition of a little pigment to give the shade desired. The bamboo grows in large quantity in Trinidad, and the extent of the sugar industry is such that there would be no lack of the raw material.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

EXAMINATIONS.

The results of the Elementary Examinations (Stage I.) have now been issued. The results of the Intermediate Examinations (Stage II.) were published on August 6th, and the results of the Advanced Examinations (Stage III.) on July 6th.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

BREWING AND MODERN SCIENCE.

By Professor ADRIAN J. BROWN, F.R.S.

Lecture III.—Delivered February 20th, 1911.

THE MASHING PROCESS.

My last lecture was an attempt to describe the position of our present knowledge in connection with some of the complex biological problems which are associated with the germination of the barley corn and the production of malt. This evening I purpose to discuss certain problems associated with the brewer's mashing process.

The mashing process by which the brewer obtains his sweet wort from malt is very usually regarded as the commencement of brewing; but in reality the actions which take place in the brewer's mash-tub have their origin in the germination changes of the barley corn when it is on the malting floor, and may be looked at as a continuation of these changes. In the last lecture we saw how nature had provided the barley corn with a large store of starch and other suitable material as a food-supply for the embryo during its development. If germination of the corn proceeds unchecked, the whole of this food-supply is assimilated by the embryo after it has been transformed by the diastase and other enzymes of the corn into sugar and other soluble nutritive material. In the preparation of malt, however, germination changes in the barley corn are arrested by drying at a comparatively early stage, prior to the occurrence of any marked solution of the endosperm, but at a time when an accumulation of diastase and other enzymes has already taken place within the corn. Under these conditions the malted corn is potentially self-digestive, and when it is placed, as in the mashing process, under conditions favourable to the action of its contained enzymes, transformation of the endospermic food reserve into sugar and other soluble constituents takes place. So the production of the brewer's sweet wort is due to an artifice of man by means of which digestion of the starchy endosperm of the barley corn is made to take place in the mash-tub, instead of within the coverings of the germinating corn as designed by nature.

I have referred to the brewer's mashing process as an operation in which starch together with other solid constituents of the endosperm of the malted corn are digested, or transformed into soluble matter, by the secreted enzymes of the malt. Now, among all the changes which take place in the mash-tub, the one of prime importance to the brewer is the transformation of the starch of the malt into soluble constituents, for these soluble constituents constitute the main basis of the brewer's sweet wort, and the qualities of beer as a beverage are to a very large extent determined by their composition. It is easy to understand, therefore, that the chemistry of starch transformation is a subject of such fundamental importance in connection with the brewer's art that it is very desirable for me to refer to it in these lectures. I confess, however, that I approach the subject with great hesitation, and if it were possible I would gladly avoid it altogether. In the first place the great complexity of the subject, and the vast amount of work which has been done in connection with it, renders it impossible for

me to do it full justice in the time at my disposal, even if I dared venture to inflict details of investigations on my audience which are only suitable for specialists in carbo-hydrate chemistry; and, in the second place, the difficulties of handling the subject are enhanced by the knowledge that a militant spirit is apt to be called into vigorous existence when the nature of starch and its transformation products is discussed from any point of view. To navigate a suitable and safe course between Scylla and Charybdis is, I fear, beyond my powers, but under the stress of circumstances I feel compelled to make the attempt.

The birth of our modern views of the chemistry of starch and its transformation products dates from 1872, when Cornelius O'Sullivan made his noteworthy rediscovery of maltose,* and demonstrated that it was this sugar and not glucose which was formed during the transformation or hydrolysis of starch by diastase. Previous to this time the hydrolysis of starch by diastase was supposed to result in the formation of the sugar dextrose, and a gum-like body, dextrin, in some such manner as is represented by the following chemical expression

$$\underset{\text{Starch}}{2C_6H_{10}O_5} + H_2O = \underset{\text{Dextrose}}{C_6H_{12}O_6} + \underset{\text{Dextrin.}}{C_6H_{10}O_5}$$

Even as late as 1873, when Dr. Graham delivered his course of lectures on brewing, he was not in possession of very full knowledge concerning O'Sullivan's discoveries, and for the most part Graham's treatment of the subject of starch transformation in the mash-tub was based on the incorrect assumption that dextrose and dextrin were the products formed.

C. O'Sullivan's discovery that maltose, not dextrose, was the sugar produced during starch hydrolysis by diastase exerted a profound influence on the progress of knowledge in connection with starch transformation. Older conceptions were modified or swept away, and a new field of work was opened up for investigation which promised results of the greatest importance for science and technology. But this field of work, so attractive in its possibilities, proved much more complex than it originally appeared when O'Sullivan commenced to study it, and for the past thirty-eight years it has provided chemists with problems of unsurpassed difficulty. Until we look into the history of the subject, it is difficult to realise what a vast amount of work has been carried on in connection with it from the time of O'Sullivan's early work until the present day. Among the chief investigators of the subject, commencing with O'Sullivan, we find such names as Musculus and Grüber, Brown and Heron, C. J. Lintner, Brown and Morris, Ling and Baker, Syniewski, Brown and Millar, Ling and Davis, Ford, Fernbach, and Maquenne, all of whom have contributed largely to the advance of knowledge of the subject. But notwithstanding the vast amount of work which has been carried out by these and other investigators, essential points in connection with the subject are still in dispute, and at the present time there is no general agreement to accept any one of the views which have been advanced to explain the constitution of the starch molecule and the manner in which it breaks down under the influence of diastase. It is impossible, under these conditions, to review within the time at my disposal the position of our knowledge of this subject in all the various aspects in which it has been presented by its numerous investigators. I propose, therefore, to confine my remarks to a few only of the many views which have been advanced to explain the subject, selecting for this purpose those which appear to follow each other in an ordered sequence and to terminate in a more or less definite conclusion.

In the first place, I propose to refer to C. O'Sullivan's earlier investigations, which unquestionably constitute the foundation on which all subsequent work on the transformation of starch by diastase has been based.

From the result of O'Sullivan's early investigations, which demonstrated that maltose, not dextrose, was the sugar formed during the transformation of starch by diastase, this author formed the opinion that starch, when hydrolysed by diastase, was dissociated into a mixture of maltose and a gum, dextrin, and that these two carbo-hydrates constituted the sole products of the change. Under these conditions it appeared possible, therefore, to represent the general character of the action of diastase on starch by some such chemical expression as the following

$$\underset{\text{Starch}}{3C_6H_{10}O_5} + H_2O = \underset{\text{Maltose}}{C_{12}H_{22}O_{11}} + \underset{\text{Dextrin.}}{C_6H_{10}O_5}$$

Subsequent investigation of the subject by O'Sullivan himself* not only confirmed this opinion, but further demonstrated the highly important fact that the temperature at which the conversion of starch proceeds exercises a very great influence on the character of the

* *Journal of the Chemical Society*, 1872, Vol. XXV., p. 579.

* *Journal of the Chemical Society*, 1876, Vol. II., p. 125.

changes which take place. It had long been known that when the temperature during starch conversion much exceeded 70° C. (158° F.) the hydrolysing action of diastase on starch was arrested; but O'Sullivan's investigations demonstrated that at varying temperatures below the one at which diastase ceases to be active, very marked differences are observed in the relative quantities of maltose and dextrin formed. For instance, O'Sullivan showed that when hydrolysis of starch is effected by malt diastase at any temperature below 63° C. (145° F.), the conversion products possess an optical rotatory power and reducing power approximating closely to those of a mixture of maltose and dextrin in the proportions of 68 to 32. This conversion change was assumed by O'Sullivan to be represented by the following equation

A.—

$$\underset{\text{Starch}}{6C_{12}H_{20}O_{10}} + 4H_2O = \underset{\text{Maltose}}{4C_{12}H_{22}O_{11}} + \underset{\text{Dextrin.}}{2C_{12}H_{20}O_{10}}$$

Again, O'Sullivan showed that if a starch conversion was carried on at any temperature between 64° C. and 68° C. (147°–154° F.) the products of conversion exhibit an optical rotatory power and reducing power closely approximating to those of a mixture of maltose and dextrin in the proportions of 35 to 65. This change was supposed to be represented by the equation

B.—

$$6C_{12}H_{20}O_{10} + 2H_2O = 2C_{12}H_{22}O_{11} + 4C_{12}H_{20}O_{10}$$

O'Sullivan further demonstrated, when a conversion was carried on between the temperatures of 68° C. (154° F.) and 70° C. (158° F.)—the point at which the activity of diastase tends to be destroyed—that the optical rotatory power and reducing power of the transformation products agree closely with those of a mixture of maltose and dextrin in the proportions of 17 to 83. This change was assumed to be represented by the equation

C.—

$$6C_{12}H_{20}O_{10} + H_2O = C_{12}H_{22}O_{11} + 5C_{12}H_{20}O_{10}.$$

These early investigations of O'Sullivan appeared to indicate, therefore, that the transformation of starch by diastase into maltose and dextrin took place in three definite changes, the character of which was determined by temperature and represented by the equations *A. B.* and *C.* given above.

But when this subject was reinvestigated by H. Brown and Heron in 1879, these chemists were unable to confirm the definite character of O'Sullivan's three equations, and the results of their investigations led them to regard the transformation of starch from a different point of view to the one advanced by O'Sullivan. O'Sullivan supposed that starch was hydrolysed by diastase to maltose and a dextrin possessing a definite and simple structure, the relative amounts of maltose and dextrin being determined by the temperature at which transformation takes place. Brown and Heron, in agreement with a view previously advanced by Musculus and Grüber, were led to regard starch as a carbo-hydrate possessing a very large molecule, which did not, as O'Sullivan supposed, break down at once under the influence of diastase into maltose and a definite dextrin, but into maltose through a series of dextrins of gradually decreasing complexity. They conceived the idea that the molecule of soluble starch was represented by the formula $10(C_{12}H_{20}O_{10})$. The first step in the breaking down of this complex molecule was supposed to consist in the hydration of one of its $C_{12}H_{20}O_{10}$ groups with the formation of a molecule of maltose, the remaining nine $C_{12}H_{20}O_{10}$ groups constituting the first complex dextrin molecule, named erythrodextrin *a*, thus

I.—

$$\underset{\text{Starch}}{10(C_{12}H_{20}O_{10})} + H_2O = \underset{\text{Maltose}}{C_{12}H_{22}O_{11}} + \underset{\text{Erythrodextrin } a.}{9(C_{12}H_{20}O_{10})}$$

The molecule of erythrodextrin *a* was next supposed to be hydrolysed in the following manner

II.—

$$\underset{\text{Erythrodextrin } a}{9(C_{12}H_{20}O_{10})} + H_2O = C_{12}H_{22}O_{11} + \underset{\text{Erythrodextrin } \beta.}{8(C_{12}H_{20}O_{10})}$$

The next stage thus

III.—

$$\underset{\text{Erythrodextrin } \beta.}{8(C_{12}H_{20}O_{10})} + H_2O = C_{12}H_{22}O_{11} + \underset{\text{Achrodextrin } a.}{7(C_{12}H_{20}O_{10})}$$

Hydration was assumed to proceed in this manner through ten stages, until finally the last $C_{12}H_{20}O_{10}$ group of the original starch molecule was transformed into maltose.

The sequence in which these ten changes was supposed to proceed is represented in the following equation

$$\begin{array}{l} \\ 10(C_{12}H_{20}O_{10}) + \\ \text{Soluble starch} \\ \text{molecule.} \end{array} \left\{ \begin{array}{rcl} & \text{Dextrins} & \text{Maltose.} \\ 1H_2O = & 9(C_{12}H_{20}O_{10}) + & C_{12}H_{22}O_{11} \\ 2H_2O = & 8(C_{12}H_{20}O_{10}) + & 2C_{12}H_{22}O_{11} \\ 3H_2O = & 7(C_{12}H_{20}O_{10}) + & 3C_{12}H_{22}O_{11} \\ 4H_2O = & 6(C_{12}H_{20}O_{10}) + & 4C_{12}H_{22}O_{11} \\ 5H_2O = & 5(C_{12}H_{20}O_{10}) + & 5C_{12}H_{22}O_{11} \\ 6H_2O = & 4(C_{12}H_{20}O_{10}) + & 6C_{12}H_{22}O_{11} \\ 7H_2O = & 3(C_{12}H_{20}O_{10}) + & 7C_{12}H_{22}O_{11} \\ 8H_2O = & 2(C_{12}H_{20}O_{10}) + & 8C_{12}H_{22}O_{11} \\ 9H_2O = & 1(C_{12}H_{20}O_{10}) + & 9C_{12}H_{22}O_{11} \\ 10H_2O = & — & 10C_{12}H_{22}O_{11} \end{array} \right.$$

But the hypothesis of H. Brown and Heron regarding the hydrolysis of starch to which I have just referred, was subsequently modified very considerably by researches on the same subject by H. Brown and Morris.*

One of the marked features noticeable when laboratory starch conversions are conducted at any temperature favourable to the full activity of diastase, is the tendency they possess of coming rapidly to a state of quasi-equilibrium when the products of change are represented by the equation

$$\underset{\text{Starch}}{10(C_{12}H_{20}O_{10})} + 8H_2O = \underset{\text{Dextrin}}{2C_{12}H_{20}O_{10}} + \underset{\text{Maltose}}{8C_{12}H_{22}O_{11}}$$

which is the No. 8 equation of Brown and Heron (see above). Transformation of starch through the different higher dextrins of Brown and Heron appears to take place with very considerable rapidity down to this stage, and then a dextrin seems to be formed which is hydrolysable by diastase only with extreme slowness. The strong resistance of the dextrin of the No. 8 equation to hydration appeared to indicate that there must be some marked difference in the constitution of this dextrin to that of the dextrins of the higher conversions, and Brown and Morris made a special investigation of this point by separating the dextrins of different equations and examining them. The stable dextrin of the No. 8 equation appeared to possess a definite optical rotatory power, and no reducing power; on the other hand, of the higher dextrins examined, all possessed some reducing power and an optical rotatory power which was less than that of the stable dextrin of the No. 8 equation. Further, it was found that if the higher dextrins were acted on by diastase they were very rapidly hydrolysed to a mixture of maltose and the same non-reducing stable dextrin as that of the No. 8 equation.

As it appeared, from the results of Brown and Morris's investigations, that the stable dextrin of the No. 8 equation differed in a marked manner from the higher dextrins of Brown and Heron, Brown and Morris were led to advance a hypothesis regarding the nature of starch transformation which differed very materially from that of Brown and Heron.

In the change represented by the No. 8 equation it will be observed that one-fifth of the starch concerned in the change is converted into stable dextrin, thus

$$\underset{\text{Starch}}{10(C_{12}H_{20}O_{10})} + 8H_2O = \underset{\text{Stable Dextrin}}{2C_{12}H_{20}O_{10}} + \underset{\text{Maltose.}}{8C_{12}H_{22}O_{11}}$$

* *Journal of the Chemical Society*, 1885, p. 527; 1888, p. 610; 1889, p. 449; 1889, p. 462.

Under these conditions Brown and Morris were led to regard the molecule of starch as being composed not of ten groups of $C_{12}H_{20}O_{10}$, as suggested by Brown and Heron, but of five such groups, four of which were similar in character and were readily hydrolysed to maltose by diastase, the remaining fifth group of a more resistant character constituting stable dextrin. According to this hypothesis, starch transformation at a temperature of 60° C. or below may be represented by the following equation

$$5(C_{12}H_{20}O_{10}) + 4H_2O = 4C_{12}H_{22}O_{11} + (C_{12}H_{20}O_{10}).$$

But it will be noticed that this equation does not of necessity indicate the magnitude of the starch molecule which takes part in the transformation. It is evident, however, from the equation that the molecule of stable dextrin must be one-fifth the size of the starch molecule. What, therefore, is the size of the stable dextrin molecule represented in the equation by the empirical formula $(C_{12}H_{20}O_{10})$? From Brown and Morris's investigations, and subsequently from those of Brown and Millar, there is reason to believe that the molecule of stable dextrin may be represented by the formula $20(C_{12}H_{20}O_{10})$. Granting this, the molecule of soluble starch taking part in a starch transformation by diastase cannot be less than $100(C_{12}H_{20}O_{10})$. Consequently, according to the hypothesis of Brown and Morris, the probable molecular expression for a transformation of starch according with the No. 8 equation is

$$\left.\begin{matrix}(C_{12}H_{20}O_{10})_{20}\\(C_{12}H_{20}O_{10})_{20}\\(C_{12}H_{20}O_{10})_{20}\\(C_{12}H_{20}O_{10})_{20}\\(C_{12}H_{20}O_{10})_{20}\end{matrix}\right\}\begin{matrix}+ 80H_2O\\ = (C_{12}H_{20}O_{10})_{20} + 80C_{12}H_{22}O_{11}.\end{matrix}$$

According to this conception, four of the $(C_{12}H_{20}O_{10})_{20}$ groups in the starch molecule are of a similar nature and are readily hydrolysed to maltose; but the fifth group is of a different nature and splits off during hydrolysis to form the stable dextrin of the No. 8 equation.*

So far no attempt has been made to explain

* It will be noticed that the conception that the starch molecule is not less than $100(C_{12}H_{20}O_{10})$ depends on the accuracy of the view that the molecule of dextrin is $20(C_{12}H_{20}O_{10})$. Brown and Morris arrived at the conclusion that the molecule was of this size from the freezing-point method, and Brown and Millar arrived at a similar conclusion from analysis of the calcium salt of dextrinic acid—an acid formed by oxidation of the so-called "stable dextrin." The reliability of the methods employed by these investigators has been questioned; but so far, no direct experimental evidence has been brought forward which tends to invalidate their conclusion.

by means of Brown and Morris's hypothesis the nature of the reducing dextrins of high type which were shown by Brown and Heron to exist in the earlier stages of a starch transformation. The origin of the reducing dextrins, according to Brown and Morris, is in the four groups of the starch molecule which are finally converted into maltose in an unrestricted conversion. These groups, during hydration, are supposed to break down gradually into maltose through a varying series of reducing dextrins, or so-called malto-dextrins, the molecules of which appear to consist of maltose and dextrin in a somewhat loose state of combination. The manner in which each of the four completely hydrolysable groups of the starch molecule breaks down through a series of malto-dextrins of gradually increasing reducing power and decreasing optical activity is indicated by Brown and Morris in the following way

$$(C_{12}H_{20}O_{10})_{20} + H_2O = \begin{cases} (C_{12}H_{22}O_{11}) \\ (C_{12}H_{20}O_{10})_{19} \end{cases}$$

$$= \text{Malto-dextrin with ratio } \frac{1 \text{ Maltose}}{19 \text{ Dextrin}}.$$

$$(C_{12}H_{20}O_{10})_{20} + 10H_2O = \begin{cases} (C_{12}H_{22}O_{11})_{10} \\ (C_{12}H_{20}O_{10})_{10} \end{cases}$$

$$= \text{Malto-dextrin with ratio } \frac{10 \text{ Maltose}}{10 \text{ Dextrin}}.$$

$$(C_{12}H_{20}O_{10})_{20} + 19H_2O = \begin{cases} (C_{12}H_{22}O_{11})_{19} \\ (C_{12}H_{20}O_{10}) \end{cases}$$

$$= \text{Malto-dextrin with ratio } \frac{19 \text{ Maltose}}{1 \text{ Dextrin}}.$$

In a starch conversion restricted by heat or other condition, it is assumed that any of these malto-dextrins, or mixtures of a number of them, may be obtained.

The first stage in the hydrolysis of the starch molecule may perhaps be represented by the following equation

$$\left.\begin{matrix} (C_{12}H_{20}O_{10})_{20} \\ (C_{12}H_{20}O_{10})_{20} \\ (C_{12}H_{20}O_{10})_{20} \\ (C_{12}H_{20}O_{10})_{20} \\ (C_{12}H_{20}O_{10})_{20} \end{matrix}\right\} + 4H_2O$$

$$= \underset{\text{Stable dextrin}}{(C_{12}H_{20}O_{10})_{20}} + 4 \underset{\substack{\text{Highest type} \\ \text{Malto-dextrin,}}}{\begin{cases} (C_{12}H_{22}O_{11}) \\ (C_{12}H_{20}O_{10})_{19} \end{cases}}$$

in which the molecule of starch is dissociated into its five main groups; the fifth group, which strongly resists hydrolysis, is split off to form the stable dextrin of the No. 8 equation. The other four groups are each hydrolysed to the highest type of malto-dextrin containing maltose and dextrin in the proportion of 1 maltose to 19 dextrin.

Subsequently, as hydration proceeds, the stable dextrin remains unchanged, but the malto-dextrin molecules are further hydrolysed—some may be completely hydrolysed to free maltose, and others to lower-type malto-dextrins. If hydrolysis is arrested by high temperature, or other influence, some such position may be reached as is indicated by the following equation

$$\left.\begin{matrix} (C_{12}H_{20}O_{10})_{20} \\ (C_{12}H_{20}O_{10})_{20} \\ (C_{12}H_{20}O_{10})_{20} \\ (C_{12}H_{20}O_{10})_{20} \\ (C_{12}H_{20}O_{10})_{20} \end{matrix}\right\} + 60H_2O$$

$$= \underset{\text{Stable dextrin}}{(C_{12}H_{20}O_{10})_{20}} + 2 \underset{\text{Malto-dextrin}}{\begin{cases} (C_{12}H_{22}O_{11})_{10} \\ (C_{12}H_{20}O_{10})_{10} \end{cases}} + \underset{\text{Free maltose.}}{40C_{12}H_{22}O_{11}}$$

This equation should be looked at, however, as illustrating only the general character of change during restricted conversion. It is probable, according to Brown and Morris, that the malto-dextrins existing at any time during starch hydrolysis, are mixtures of various types—not one type, such as is indicated in the above equation.

A point of much technical importance which remains for discussion concerns the properties of the malto-dextrins, or reducing dextrins formed during starch hydrolysis. These bodies, although they possess an optical rotatory power and reducing power closely resembling those of mixtures of maltose and stable dextrin and were considered to be mixtures in the earlier days of investigation, have been shown by Brown and Morris to be definite compounds. For instance, when their characteristics were compared with those of a mixture of maltose and stable dextrin, such as is obtained by the unrestricted conversion of starch to the No. 8 equation, it was found that primary yeast readily fermented the whole of the free maltose which was present in the mixed conversion products and left the stable dextrin unaltered; on the other hand, the malto-dextrins of a restricted starch conversion were found to be unfermentable by the same type of yeast. Again, it was found that fractional precipitation with alcohol effected a separation of dextrin from maltose when the two existed together in solution as a mixture; but no fractionation of dextrin from maltose could be effected by similar treatment of solutions of malto-dextrins. A very marked difference was also observed in the behaviour of malto-dextrins and the mixed starch conversion products of the No. 8 equation when under the influence of diastase at temperatures below

60° C. (140° F.). It was found that no appreciable change took place within a limited time in the case of mixtures of dextrin and maltose, but malto-dextrins were very rapidly hydrolysed to pure maltose. The latter result, of course, should be observed if—according to the Brown and Morris hypothesis—malto-dextrins represent partially hydrolysed portions of the four groupings of the starch molecule which are so readily attacked during an unrestricted starch transformation.

From a technical point of view, the unfermentable nature of the malto-dextrins, or reducing dextrins, assumed by the Brown and Morris hypothesis to be present among the products of a restricted starch conversion, is a matter of great importance. If the starch transformation products constituting the greater part of the soluble matter of the brewer's malt wort consisted of maltose and stable dextrin only, the whole of the maltose would be transformed into alcohol and carbon dioxide during fermentation in the brewery, and the fermented liquid would be highly alcoholic and very "thin" in palate flavour owing to complete removal of the sweet "body-giving" constituents originally contained in it. Moreover, when the fermented wort was placed in cask it would contain no carbohydrate matter suitable for generating the secondary fermentation changes which are so essential for the proper "conditioning" of beer, and it would remain a thin, "flat" liquid, very different from the full-drinking beverage charged with carbon dioxide which we recognise as beer. The brewer knows, however, that during the primary fermentation of his malt wort in the brewery the whole of the sweet-flavoured constituents of his wort does not ferment away, and that some portion is left which gives sweetness and "palate fulness" to his beer. He knows, moreover, that some fermentable matter still exists in his finished beer—not readily fermentable matter, or it would have fermented away during primary fermentation in the brewery—but matter capable of sustaining a slow secondary fermentation in cask or bottle for months, or may be for years.

Both of these phenomena of such ruling importance in the brewing industry are explained if we recognise that carbohydrates are present in the brewer's wort which possess similar characteristics to those of the malto-dextrins, or reducing dextrins, indicated by Brown and Morris's researches. We have already seen that malto-dextrins are unfermentable by primary yeast, hence their presence in a brewer's wort explains the persistence of the sweet-flavoured constituents noticeable in the wort after it has undergone primary fermentation and has been converted into beer in the brewery. The highly important influence of the malto-dextrins in establishing the secondary conditioning of beer is also explained by the knowledge that, although malto-dextrins are not fermentable during primary fermentation in the brewery, they are slowly fermented by the so-called "secondary" yeast forms which develop in beer when in cask or bottle. Yeasts of this type appear to generate enzymes capable of very slowly hydrolysing the complex malto-dextrin molecule to free maltose, the sugar liberated being subsequently decomposed by the yeast into carbon dioxide and alcohol, thus giving rise to the phenomenon of "secondary fermentation," or "conditioning" of beer.

With regard to the presence of malto-dextrins in the brewer's wort, it will be noticed that the heat at which the brewer conducts his mashing operations approximates closely to 66° C. (151° F.), a temperature which restricts hydrolysis of starch by diastase and consequently favours the production of malto-dextrins.

Subsequent to Brown and Morris's investigations, the results of which I have endeavoured to explain, Brown, working in conjunction with Millar, conducted further researches,* which led to a slight modification of the view of Brown and Morris regarding the constitution of the starch molecule. The so-called stable dextrin of the No. 8 equation, which is supposed to be derived from one of the five groupings of the starch molecule, was regarded by Brown and Morris as a non-reducing dextrin containing twenty so-called "maltase" groups

$$(C_{12}H_{20}O_{10})_{20}$$

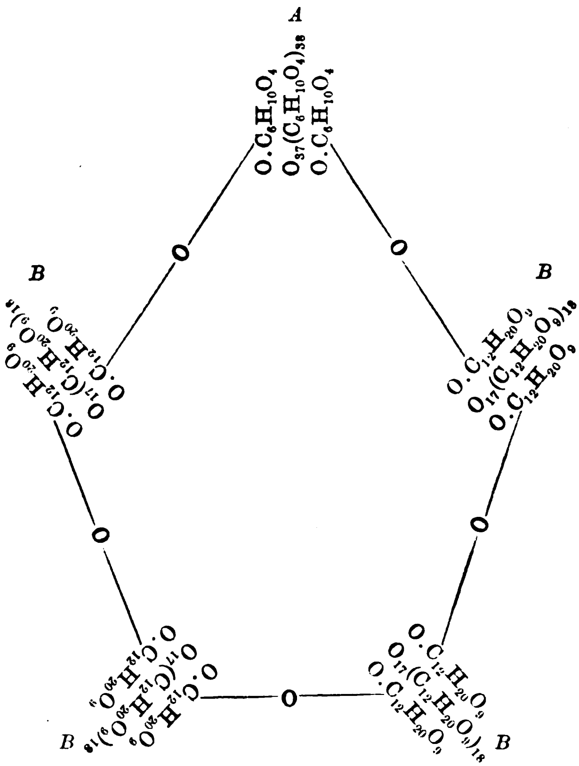
Non-reducing dextrin.

But Brown and Millar, from the results of further work, satisfied themselves that "stable" dextrin possesses a small reducing power due to the existence in its molecule of a $C_6H_{12}O_6$ (dextrose) group. Under these conditions they could no longer regard the stable grouping of the starch molecule, which yields dextrin, as composed of twenty $(C_{12}H_{20}O_{10})$ groups, but as containing thirty-nine $C_6H_{10}O_5$ groups and one $C_6H_{12}O_6$ group as represented in the following formula

$$\begin{cases} (C_6H_{10}O_5)_{39} \\ C_6H_{12}O_6 \end{cases}$$

* *Journal of the Chemical Society*, 1899, Vol. LXXV., p. 315.

The final picture of the possible constitutional formula of the molecule of soluble starch proposed by Brown and Millar is given below.



A. Dextran residue.
B. Maltan residues.

At the commencement of this lecture I stated that it was impossible within the brief time at my disposal to discuss thoroughly the progress of knowledge regarding our modern knowledge of starch transformation owing to the complexity of the subject, and the overwhelming amount of work which has been done in connection with it. In order to meet this somewhat impossible situation as well as I could, I proposed to refer to one line of investigation only which exhibits consistent progress towards the foundation of a definite hypothesis. It was for this reason I have selected O'Sullivan's original work as the foundation of my remarks, and have followed by endeavouring to show how the final hypothesis of Brown, Morris and Millar has developed from it. I regret that through treating my subject in this way I have not been able to refer to the work of many notable investigators, such as C. Lintner and Syniewski—or even to the work of Maquenne and Roux, Fernbach, and others of the French school, which is still proceeding and which gives promise of most important results—but, if I had attempted to do otherwise, I felt it must infallibly end in confusing my audience, whom I cannot altogether regard as specialists in carbohydrate chemistry. As it is, owing to the complex nature of the chemistry of my subject, I fear my remarks must have proved somewhat difficult to follow.

The view of Brown, Morris and Millar regarding the constitution of the starch molecule and the manner in which it is transformed when under the influence of diastase is not regarded favourably by all starch specialists—in fact, it appears to exert a peculiarly irritating effect on the minds of some; but, on the other hand, although the view has been very severely criticised from time to time, I am not aware of the existence of any experimental evidence which has, as yet, seriously questioned its validity. Moreover, no other view advanced at present appears capable of explaining so much—and this is a matter of prime importance with regard to its value as a working hypothesis. Nevertheless, it is well to bear in mind the great difficulties which surround such an investigation as that of the action of diastase on starch, and the probability of future work leading to some modification of any view yet advanced.

There are very many points in connection with diastase and enzymes of a kindred nature present in malt about which much uncertainty exists. Do several forms of diastase exist in malt, contributing to the different stages in the degradation of the starch molecule which have been observed by so many investigators? From the influence of heat on the products of starch transformation, and from other evidence brought forward by Maquenne and Roux, it is probable that such may be the case, but at present we are waiting for solid proof that it is so. Again, what is the nature and *rôle* of the liquefying enzyme which plays such an important part in the modification of starch paste, and in the solution of starch in the brewer's mash-tub? Probably it is a different enzyme from the ordinary diastase of transformation, but there is much in connection with this question which is of great technical and

scientific importance and which requires further investigation.

Consideration of such questions as these brings forward another point of great importance in brewing technology. We have seen that the hypothesis of Brown, Morris and Millar appears to be in agreement with the phenomena observed during the hydrolysis of starch by diastase under laboratory conditions when the enzyme in comparatively small amount acts on starch paste, or soluble starch. Are the results observed during starch conversion in the brewer's mash-tub, when diastase in very large amount acts on the starch granules of malt, also in agreement with Brown and Morris's hypothesis? Viewed broadly, they present a general appearance of agreement, but looked at closely they are usually found to vary materially from those which Brown and Morris's hypothesis would lead us to expect.

Temperature appears to influence the nature of starch transformation by diastase to a much greater extent when the action proceeds under laboratory conditions, than when it takes place in the brewer's mash-tub, and it is by no means safe to assume that the results obtained at any particular temperature in the mash-tub will be similar to those obtained at the same temperature in a laboratory starch transformation. This does not, however, of necessity throw doubt on the soundness of Brown and Morris's hypothesis. This hypothesis is founded on the results of laboratory experiments in which the conditions of experiment were kept as free as possible from complicating factors. The conclusions derived from experiments such as these may be correct, and yet they may not be able to explain the nature of starch transformation in the mash-tub, owing to other actions taking place during the brewer's mashing process which obscure, or modify, the actions observed in a laboratory starch transformation.

Brief consideration of the conditions ruling during mash-tub conversion will show how complex the conditions are as compared with those of an ordinary laboratory conversion. Action in the mash-tub commences on solid starch granules—not on starch paste or a solution of soluble starch, as in a laboratory starch conversion—and it is initiated by the activity of one or more enzymes of which we know little, which assist in gelatinising and liquefying the starch. Following immediately on these changes, the soluble starch is brought under the influence of a very large excess of diastase derived from the malt, a condition very different from that of an ordinary laboratory starch conversion in which only a limited amount of diastase is employed. Moreover, during conversion changes in the mash-tub another difference of condition exists, which probably exerts an important influence on the nature of the occurring starch transformation. This consists in the presence of a large amount of soluble and insoluble material of very various nature derived from the malt, and it is well known how susceptible the actions of diastase and other enzymes are to influences such as these. Therefore, under the complex conditions of starch transformation in the brewer's mash-tub referred to, it is reasonable to expect that the character of the changes will differ from those taking place under similar conditions of temperature in a simple laboratory starch transformation.

Our knowledge of starch and its conversion changes has undoubtedly increased very much during the past thirty-seven years, but, notwithstanding the vast amount of work which has been done in connection with these subjects, we are not yet masters of the complex changes which proceed during starch transformation in the mash-tub. It is disappointing to be compelled to say this, but it is highly desirable that the fact should be recognised in order to encourage future investigation in a direction of the very greatest importance to the brewer, the distiller, and the vinegar-maker. If the subject of starch, which I have discussed this evening with some trepidation, had not become such a very controversial one, we should have proceeded faster and further in our search after knowledge. There is no doubt a humorous side to starch polemics which some of us value, but we could well afford to sacrifice this for the advantages of calmer discussion and more rapid progress.

ECONOMIC ASPECTS OF THE INTRODUCTION AND ESTABLISHMENT OF A BRITISH BEET-SUGAR INDUSTRY.*

Great Britain is the greatest sugar consumer in the world. We imported last year (1910) 1,745,129 tons of sugar, of which 1,303,319 tons were beet-sugar, and 441,810 tons cane-sugar. We sent abroad last year £25,307,214 for sugar. The question may well be asked whether we can keep this immense amount of money in our country by

* Abstract of a paper read by Mr. Sigismund Stein before the Section of Economic Science and Statistics of the British Association at Portsmouth, 1911.

producing the sugar ourselves. England distinguishes herself by being the only country in Europe which does not produce a single ounce of sugar herself. I have proved by over four thousand sugar-beet growing experiments, conducted in practically every county in the United Kingdom in the last twenty consecutive years, that we can successfully grow sugar-beet in these islands. The beet cultivation in Germany brought an increase on the yield of all crops. The beet culture forced the farmer to adopt very deep ploughing, along with scientific farming, and to proper treatment of the soil both chemically and physically. The ingenuity of the agricultural engineer invented new implements and machinery for this new departure in agriculture. The by-products and residue of the beet-sugar industry, called beet-pulp or "slices," are a very valuable cattle-food, by which the number of cattle could easily be increased, also the fattening of cattle fostered.

In Europe alone fifty million tons of sugar beetroot are cropped per year. Out of this vast quantity twenty-five million tons of sugar-beet pulp are produced, which are all used for cattle-feeding. This enormous quantity of cattle-food has been the means of considerably increasing the number of cattle on the Continent. England has entirely given herself up to manufacture and neglected agriculture, while Continental countries like Germany, where industry and manufacture have increased and improved at the same pace as ours, have not neglected agriculture. The question of employment is at the present moment a very pressing problem indeed. The 1,065,645 people in the United Kingdom who are under poor relief (1910), the many thousands of men and women we find in large towns and cities without employment, can be well occupied by the introduction of sugar-beet cultivation. If we introduce this gigantic industry into this country we would employ over 160,000 men in our sugar factories, about 200,000 men would find employment in the trades that work in connection with the sugar industry, and another 240,000 men would find additional employment in the fields. Taking it all round, by the work provided by the introduction of the beet-sugar industry, 600,000 men would find employment, representing 450,000 families, which at four per family would mean that 1,800,000, equal to 4 per cent. of the whole population, would be interested in the beet-sugar industry. Our position in the world depends upon maintaining a large rural population. We all read the sore and disquieting accounts of the depopulation of different districts in our islands. This ever-increasing exodus, which robs the country of the best healthy working men and women and a sturdy agricultural population and drives them into other countries, where they find more favourable economic conditions, and where they work in competition against us, could be stopped. The sugar-beet is most admirably adapted for small holdings. No other crop is so suitable, because sugar-beet can be grown year after year on the same land or with rotation.

To cover our demand for sugar we require five hundred factories to supply us with sugar, each factory would cost £80,000, so that £40,000,000 might be safely and profitably invested at home. The £25,000,000 sterling we send year by year to foreign countries would remain here, increase our wealth, benefit British agriculture, British trade and commerce, and British capital and labour. The high dividends paid during the last years by most Continental beet-sugar factories show the profitability of this industry. Our export of capital has already reached excessive dimensions. To produce all the sugar we consume we would require about a million acres to be cultivated with beet, which we could easily reclaim from the land that went out of cultivation during the last decade. In the progress of economic thought and study, and mainly through the efforts and zeal of practical British economists, the bounties which have been a menace for over thirty years have been abolished since September 1st, 1903. With the introduction of the beet-sugar industry there would go hand in hand the creation of the sugar-engineering industry and the agricultural-implement industry. To give an example of what would be required if we produced all the sugar we consume, I may mention that twelve million tons of beetroot would be necessary, one million tons of coal, 600,000 tons of limestone, 70,000 tons of coke, twenty million bags, four million cases, and an immense quantity of other materials.

SMOKE ABATEMENT: THE POSSIBILITY OF FIXING A NEW STANDARD OF SMOKE EMISSION FROM FACTORY CHIMNEYS.*

From the point of view of smoke emission the present position of the manufacturer who burns bituminous coal in his furnace is that, while he knows dense smoke to be unnecessary and wasteful, entire absence of smoke is practically impossible to attain under working conditions. The question, therefore, is, What is the least amount of smoke such a manufacturer might be asked to limit himself to?

The present legal standard of "black smoke in sufficient quantity to be a nuisance" is admittedly unsatisfactory, as black smoke is a thing rarely if ever seen; also, the blackness alone is no measure of the amount of pollution nor even of the amount of soot per ton of coal burnt. The present standard is therefore out of date. Meanwhile the public have to breathe polluted air, to suffer in health and pocket, have their buildings injured and disfigured, and their sunshine cut off.

A sound standard of maximum allowable amount

* Abstract of a paper read by Dr. J. S. Owens before the Engineering Section of the British Association at Portsmouth, 1911.

of smoke should be fixed and enforced. Two questions must be answered before such a standard can be fixed: (1) What is the best and most practicable method of measuring smoke? (2) Having decided on (1), what is a fair maximum of smoke emission to fix, as measured by (1)?

To answer the first question we must decide exactly *what* we are to measure. We may set ourselves to find out: (1) The total quantity of soot emitted in a given time; (2) the weight of soot emitted as a percentage of fuel burnt; (3) the density or weight of soot per unit volume of flue gas; (4) the ratio only of density to a standard; (5) the colour; (6) the opacity or blackness.

In deciding the method of measuring we must keep in view: (*a*) Fair comparison between chimney and chimney or with standard; (*b*) ease of application and simplicity; (*c*) reasonable accuracy; (*d*) the smoke must be measured from outside factory; (*e*) the method must be capable of use by a single observer.

The standard suggested is one of *maximum density for maximum time of emission.* By density is meant amount of soot per unit volume of flue gas. A smoke of great density would be permitted for a short time only, whereas one of less density might be permitted for a longer time.

The method of measuring the density suggested is by matching the opacity of the smoke to that of calibrated smoked glasses, each glass representing a certain density of smoke in a column of unit thickness. The final figure for comparison is obtained by dividing the density represented by the glass by the diameter of the chimney. By careful construction and the elimination of certain errors, an instrument can thus be made to give a fair basis of comparison with a standard density. The author has devised and experimented with an instrument of this type, with promising results. Certain objections will always remain to such a method of measuring, but the author believes that it is only along such lines that the necessary conditions can be fulfilled.

The Alkalies Act of 1906 fixes a standard maximum of one-fifth of a grain of muriatic acid per cubic foot in smoke or noxious fumes, and it appears that the time has arrived when the soot from furnaces should be dealt with on similar lines, modified to suit the case.

THE MANUFACTURE OF ARTIFICIAL EYES.

How such defects as the loss of an eye were remedied by the various nations in earlier years is difficult to imagine, for it appears that the first reliable report on the subject is given by the French surgeon Ambroise Paré in 1560, although a few unauthenticated reports date as far back as the Middle Ages. Two kinds of artificial eyes were known to Ambroise Paré—the ekblepharos and the hypoblepharos. The ekblepharos was made by painting the eye and all the surrounding parts as far as the brows on a plate, which was placed in front of the eye-socket, and held in position by a string tied over the head. The hypoblepharos was used in a manner similar to that of to-day, being put behind the eyelid, in the eye-socket itself, and was composed of a metal shell of copper, silver or gold, covered with enamel and glass fusions. The United States Consul-General of Coburg, who has recently reported to his Government on this subject, says that it is thought that Augsburg was the source of the enamelled shells, whence the art was taken to France, and as German art industries were ruined in the Thirty Years' War, Paris became the centre of the artificial eye industry. There are still opticians in Germany who advertise their eyes as "finest Paris eyes," although they are marked with German marks; but no less than 80 per cent. of the eyes now used in Paris, and the rest of France, are said to come from Germany. It was only at the close of the eighteenth century that these artificial eyes really became of practical use, it being then found possible to do away with the metal shell altogether and employ only enamel and glass. It is known that in the middle of the nineteenth century eyes were made by enamellers in Dresden, Prague, London and Stockholm, and in Thuringia. The Thuringian makers differed widely from the others in that they were not enamellers but glass-blowers, working in connection with the porcelain-painting industry, whose endless and untiring experiments resulted in the discovery of an ideal material, cryolite glass, the use of which led to a new technique in eye manufacture. At times, attempts have been made to replace the breakable glass by vulcanite or celluloid, but such efforts have long since been given up as useless. The fragility of artificial glass eyes, and their sudden cracking through changes of temperature, can be reduced to a minimum by careful work. If eyes crack without apparent cause it is usually a sign that they are cheap so-called "stock" eyes, where quantity rather than quality is aimed at. In 1852 the method adopted in France for making eyes was as follows: On the broadly-pressed end of a small colourless, transparent rod of enamel, the pupil was first made, and the iris was then formed on this by means of a small, thin, pointed, coloured enamel rod, the designing of the iris being made possible by melting the point of this rod. In Paris the good eyes are so made. A glass tube, closed at one end and of the colour of the sclerotic, is next blown into the form of an oval, and in the middle of this a hole is melted, the edges of which are rounded off evenly, and pressed a little outward. The iris is then placed in this opening and well melted in. A thick coating of glass remains behind. The eye is rounded off, the protecting rim of the white coat is smoothed with a metal rod, and this coat is thereby joined to the sclerotic. By means of a thin, pointed, red rod the blood vessels to be seen on the hard coat of the human eye are then melted in. The superfluous back part of the eyeball is melted off, thereby giving to the eye the desired form. The eye is finally placed on

hot sand, where it gradually cools off. Glass eyes are made in quite a different manner in Lauscha, the centre of the industry in Germany, where their manufacture is altogether a house industry. The eyes are usually made by one member of a family, and the art is handed down from one generation to another. A gas flame is used for melting the glass, and the method of manufacture is as follows: A small drop of white glass is put on the white blown ball from which the sclerotic is to be made, and is then blown so as to make a circle about eight millimetres (0·315 inch) in diameter. On this circle the structure of the iris is built by means of thin variously-coloured glass rods. A drop of black glass makes the pupil. Over the finished iris crystal glass is melted in order to imitate the cornea. The further manufacture is similar to that given in the first description.

THE MARSEILLES PEANUT-OIL INDUSTRY.

Peanut oil ranks next to olive oil in popular favour, being generally preferred in France to cotton oil. It is highly rated as a salad and a cooking oil, and is used extensively in the manufacture of margarine and by sardine packers. It is frequently mixed with olive and other vegetable oils. The industrial grades obtained from the Indian nuts, and the second pressings of the African varieties, are consumed mainly by the soap-making industry, but a certain proportion is also employed for illuminating and lubricating purposes. The Marseilles mills produced in 1910, 170,000 tons of peanut-oil cake. The cake is used for cattle feeding. About 80,000 tons are exported annually, chiefly to Germany and Scandinavia. Peanuts in the shell are never ground whole in the Marseilles mills. On the contrary, expression of the oil is almost invariably preceded by a careful preparation of the nuts, particularly in the case of edible oil. The peanuts are crushed only after having been cleaned and decorticated, and after every effort has been made to remove entirely the germs and the red skin covering the kernels. All these operations are done by machinery. According to the United States Consul-General at Marseilles, the peanuts undergo a preliminary cleaning in a rotary sieve; they are afterwards brought by a lift to the decorticating machine and passed through grooved rollers so adjusted as to husk the nuts without crushing the kernels. The separation of the husks and kernels is effected by ventilation. The germs, sprouts, and red skin still adhering to the kernels after the husking process, are stripped off by friction against the coarse-wired meshes of a rapidly oscillating sieve, the operation being completed by a ventilator connected with the apparatus. It is extremely difficult, however, to detach the red cuticle entirely from the kernels, and in the case of new crop nuts it is said to be a practical impossibility. After the kernels have been cleaned, they are ground by a crusher provided with two pairs of rollers. The mass emerging from the rollers falls into a "sasseur," or sifter, which separates the coarse from the fine meal, the remaining stones and other foreign substances having been eliminated by an aspirator. The meal is then put into hair bags and subjected to hydraulic pressure, from twelve to fifteen bags separated by metal plates being pressed at the same time. A bag contains about ten kilogrammes (twenty-two pounds) of meal. The first pressing, which furnishes the high-grade oil, is made without heating the meal. This pressing lasts usually about one hour. For the second pressing the bags are generally emptied, the meal reground, and brought to a temperature of 86° to 122° Fahrenheit, according to the quality and condition of the nuts. The same amount of pressure is applied as for the first pressing, and the same press may be used. A smaller yield but a finer grade of oil results from the second pressing when the supplementary grinding of the meal is dispensed with. In some mills a third pressure is applied, but this is an unusual practice. The yield of oil varies with the origin and condition of the nuts. The Senegal peanuts in the shell yield about 33 per cent. of their gross weight, the Gambia peanuts 31½ to 32 per cent. Both of these varieties yield from 21 to 23 per cent. on the first pressing, and 10 to 11 per cent. on the second pressing. The average oil yield of the shelled peanuts is about 39 per cent. for the Indian nuts, and 42 per cent. for the Mozambique. After running from the presses peanut oil does not need refining, but is simply filtered. It is then fit for consumption as salad oil. Bleaching is resorted to only in order to produce the white oil required in the manufacture of margarine.

THE RUSSIAN CAVIAR INDUSTRY.

The ever-increasing demand, and the diminishing supply, of sturgeon caviar led the fishermen of Eastern Siberia to experiment with salmon roe, which had not only been considered useless for human consumption but had even been looked upon as injurious to health. Up to 1907 the fishermen in the neighbourhood of Nicolaevsk considered salmon roe as valueless, but from that time it was demonstrated that caviar could be made so as to prove commercially profitable, and of such a quality that, although it cannot compare with the taste of the sturgeon caviar, it is nevertheless a great delicacy. In the preparation of salmon caviar for the market the following are the methods adopted. Along the sea-coast double-sided traps are used to catch the salmon, whereas in the rivers, in addition to drag seines, traps are used opened at the lower end only, so as to catch the fish moving upstream. No special care is taken with the fish from which it is intended to remove the roe, except that they must be absolutely fresh, and the sooner the roe is removed after capture the better the results will be. Should it be impossible to remove the roe from the fish

immediately after they are caught, they may be kept up to twenty-four hours in cold water, provided they are not confined in a small space. By this is meant that a barge-load of fish covered with cold water would be useless for caviar if kept for that length of time. The eggs are removed in the ordinary operation of cleaning the fish, the only special care necessary being to avoid rupturing the gall bladder, as this would ruin the caviar. After the roe is removed, the eggs are passed through a galvanised iron-wire sieve, copper sieves having been found injurious. During the short time that experiments have been made in the Amur River and Kamchatka it was found that the best caviar is obtained from fish over four years of age, and the best quality is obtained from the king salmon in Kamchatka. According to the American Consul at Vladivostok, there are differences in the caviar produced from the various species of salmon, that is, spring, summer, and autumn, and a marked difference has been noted in eggs taken from fish caught at or near the sea-coast, as compared with fish caught farther up the river, and it has been found that the eggs taken from fish caught far upstream are too ripe for caviar manufacture, as the completed product turns yellow, whereas good salmon caviar should be a bright golden red. After the eggs have been passed through a sieve they are washed in clear cold water and then immediately soaked in brine, and are not in any way drysalted. In addition to pure water and salt, a small quantity of greyish-white powder is mixed with the solution, and this constitutes the secret part of the process. It is believed that this powder is salicylic acid, and possibly a little borax, but experiments could be made which would show if these answer the purpose. The entire success depends upon the strength of this solution, and where methods are the crudest the peasants who prepare caviar test the strength by taste, but a brine gauge may be used for this purpose, and the salt solution should be from 19 to 22 per cent. Should the solution be too strong there is no method of removing the salt from the caviar, and the latter is ruined. The addition of the powder is to counteract the bitter taste in the salt, presumably caused by iodine, as well as for preserving the caviar. The eggs should remain in the solution from twenty-five to forty-five minutes, according to the strength of the brine and the temperature. They are then placed in bags and subjected to heavy pressure. The method employed in Eastern Siberia is to place the bags between two blocks, the upper of which is pressed towards the lower by a pole lever, at one end of which a man suspends the weight. This pressure, although great, does not crush the eggs, as they are flexible, and it causes a shrinkage in the weight of the caviar of about 40 per cent. After being subjected to this pressure the caviar is immediately packed into wooden kegs and the process is completed, no oil or other substance being added. Selected caviar is packed in one-pood (36 lbs.) kegs, the ordinary caviar in kegs weighing from three to nine poods each. Care is always taken in the kind of wood used, as it has been proved that lime and oak spoil the caviar, the latter causing it to turn black. The principal market for salmon caviar is European Russia, more particularly Moscow and St. Petersburg, and it is introduced into other countries of Europe. This caviar is known on the Russian market as "Kitovia" or "Krasnia Ekra" (salmon or red caviar).

PEAT UTILIZATION IN GERMANY.

Efforts are being made in Germany to improve the cultivation of marshes and moorland. The success attained in this direction in the Netherlands has attracted attention in Germany, particularly since Dutch gardeners and truck farmers have predicted that, were the marshes of Prussia cultivated like those of Holland, the German canned fruit and vegetable industry would conquer the markets of the world. The German marsh and moorlands cover an area of about five million acres. The largest districts by far are in Prussia, especially in the provinces of Hanover and Schleswig-Holstein, and also in Pomerania, Brandenburg, Posen, and Ost-Preussen. The best quality of peat from German soil, so called air-dry peat, contains about 45 per cent. of carbon according to the American Consul at Stettin, 1·5 per cent. of hydrogen, 28·5 per cent. of chemically-bound water, 25 per cent. of hygroscopic water, and small amounts of nitrogen. The annual production of peat in the Empire amounts to about 11 million tons. Regarding the heating qualities of the best peat, it has been established that the average peat is equal to dry beechwood at similar weight and equal to coal of half the weight. There is a vast difference, however, in heating power between the different grades of peat at equal weights. If the ash exceeds 25 per cent. the peat is deemed not adapted for fuel purposes. The percentage of ash can vary from one-half of 1 per cent. to 50 per cent. The industrial utilization of peat for lighting purposes has been attempted for many years in Germany, but as yet there has been no satisfactory solution of the problem of how to produce power-gas from peat more cheaply than from coal. In conjunction therewith the generation of ammonia and of electricity has been attracting much attention in scientific quarters, and at the last annual convention of German scientists and physicians this problem was discussed as a result of new views and investigations presented by Dr. Caro, of Berlin. In collaboration with Professor Frank, of Charlottenburg, Dr. Caro discovered a method for the economic utilization of peat which he claims avoids former mistakes, and which he described as follows. The generator consists of shaft-like ovens, where the burning of the peat is conducted in a way admitting limited quantities of air. Thus also, a dry peat in pieces can be treated, and produces a gas strongly impregnated with tar fumes, which gas, after purification from tar, will furnish a useful heating and

power gas. The inventor found that if the gasification process is properly conducted, peat containing as much as 60 per cent. of water could be used. Peat having a percentage of water above 60 could be dried down to this figure by storage in the open air. This process, Dr. Caro asserts, permits the manufacture of a good heating gas during the entire year, and he claims that it can be used in connection with the generation of electricity. In view of the absence of constant water-power in Germany, he thinks that the invention will cheapen the cost of generating current. Another result of the discovery is the extraction of nitrogen by this process, 85 per cent. of this element contained in the peat being recovered therefrom. This nitrogen can be converted into ammonia by the introduction of steam. The method admits of the production of ammonium sulphate, and thus furnishes agriculture with a valuable fertiliser. The Prussian Minister of Agriculture is now engaged in preparing a comprehensive law giving the Government extensive power to stimulate by direct financial assistance, as well as by the use of all available governmental facilities in the broadest application, all efforts for the cultivation of the German marshes and moors, although 90 per cent. of the Prussian high moorlands are in private hands.

JAPANESE RAILWAY STATISTICS.

In the course of his paper on Japan, read before the Royal Statistical Society, Mr. Charles V. Sale gave some interesting figures relating to the Japanese railways. With considerable foresight, the Government acquired the private undertakings before the capital value of these had (as in our own case) increased in such a manner as to render this impracticable. The purchase price was 48·8 millions, more than double the cost, showing how land and labour had increased in value since the railways were commenced. This purchase was authorised in 1906, some twenty-five years after railway construction had been commenced on an appreciable scale. In 1872 only eighteen miles were open, owned by the State. This had increased to 300 State and 293 private-owned by 1888, to 1,532 State and 3,251 private by 1906, and to 4,542 State and 478 private by 1909. Figures for the rolling-stock are also given. In 1872 Japan possessed 10 locomotives, 58 passenger coaches, and 75 freight wagons. At the time of the conversion to State ownership, there were 1,717 locomotives, 5,340 passenger carriages, and 27,183 goods wagons. At present there are 2,156 locomotives, 5,956 passenger carriages, and 34,045 goods wagons. A noticeable feature is the large proportion of locomotives to trailed vehicles, the proportion being 1 to 18·9 in 1906, and 18·5 at the present time. The proportion for English railways is one locomotive to 36 railway-owned vehicles. The use of a heavier locomotive is probably rendered impracticable by the narrow gauge (3 ft. 6 in.) and by the steep gradients.

The proportion of earnings to expenses was, in 1909, 100 to 53½, very good, although considerably increased of late years. In the same year the average proportion in the United Kingdom was 62 per cent.

The receipts from passengers were under a million pounds in 1891, increased to 4·29 millions by 1908, and 4·55 millions in 1909. The number of passengers has increased from 22·8 millions in 1891 to 146·9 millions in 1909. The receipts per passenger have increased, although the mileage per passenger has decreased slightly, arguing probably, shorter individual journeys.

The goods traffic brought in £284,000 in 1891, 2·8 millions in 1908, and 3·7 millions in 1909. The receipts per ton carried have considerably increased, standing at 35 pence, while the mileage per ton has also increased.

It will be noted that the total net earnings on the Japanese railways are £3,960,000 on a capital of £80,038,000, or a proportion of 4·9 per cent., whereas the English net earnings were £45,136,000 on a capital of £1,314,400,000, a percentage of only 3·4. The total receipts from all sources (a rather difficult figure to arrive at accurately) are given as 8·5 millions for Japan, and 120·17 millions for the United Kingdom. This works out at 10·6 per cent. for Japan, and 8·1 for the home railways, a lower rate which may be partly due to capital expenditure not yet remunerative, as well as, in net figures, to the expense of the directorates.

The only analysed table given is that for 1907, from which we learn that the maintenance expenses per mile were £190, as against £487 in the United Kingdom, and general expenses only £49, as against our robust figure of £270. Certainly the rates, taxes, and Government duty, from which, of course, a State railway is exempt, add a noticeable item to the expenditure of our railways, amounting to £228 per mile. The omission of this item would better the percentage of receipts to capital about ·3 of a pound, still leaving it considerably under the 4·9 per cent. of Japan.

Taking the total mileage of 1909 at 4,542, we have a capital expenditure of £17,600 a mile. The United Kingdom figures at £56,000 per mile by the same calculation, but against this has to be reckoned both wider gauge, far more expensive land, and extensive investments in docks, shipping, etc., which do not enter into the mileage.

THE BROOM INDUSTRY OF HONDURAS.

In the districts of Santa Barbara and Ilama in Honduras, there has for many years been carried on, in a small way, and as a by-product of the manufacture of panama hats, a broom industry which is now beginning to attract attention. The panama hats are made from the fibre of the Carludovica palmata, the young shoots of which are cut

just as they begin to flower. The fibre grows in concentric folds around a central stalk. It is peeled off for the hat-makers according to the fineness desired, dried in the sun, and bleached with sulphur. The United States Consul at Puerto Cortes says that the natives call these young shoots "candles," because of their shape. They are from two to three feet long, and when the outside fibre is stripped off there is left a central stalk or core, which is split, flattened out, and cut into strips for making brooms. The strips are cut into lengths of ten to fifteen inches, which are firmly tied in the centre around a broom-handle, doubled back, tied again and trimmed to the desired length and shape, and placed on the market by sending out mule-loads to the various cities and towns and hawked, *en route*, at the wayside houses and plantations. They are readily purchased by the merchants of the country in exchange for goods at prices equal to about sixpence or sevenpence, and by them retailed to the general public. They are extensively used in the railway service, the management of which finds them perfectly satisfactory, and much cheaper than the imported article. The fibre has a good spring in it, and is said to be very durable. It is proposed to ship the fibre in bulk to broom-makers in the United States in order that they may put it to certain domestic and business uses.

HOME INDUSTRIES.

The Coal Industry.—There is some reason to fear something like a national strike among the coal miners before the year is out. Dissatisfaction is rampant in Northumberland and Durham, as in Wales. And the Eight Hours Act has much to do with it. The objections to this ill-advised measure have frequently been stated in these Notes. They are restated with much force by a correspondent of the *Times* (August 31st) as follows:—"The miners were led to believe that this Act would be a boon to them. It is proving otherwise. Some of them feel that they have been betrayed, or at least deceived, by their leaders. Hence the spread of indiscipline. Others imagine that the employers are 'putting the screw on' out of spite against the men and their Federation for securing the Eight Hours law. Hence the unusually strong disposition to strike. It is not an abuse of language to say that this new law is a curse on the mining industry. Here we see an attempt to impose a uniform law upon an industry in which the conditions vary widely between district and district, and even between mine and mine, and as a result we have friction and discontent throughout the country. Even the problem of mining accidents has been intensified by this measure. Before we got the Eight Hours Act our fatal accidents represented four lives per working day. Since the Act was passed we have been killing our miners at the rate of six per day. Non-fatal accidents have, of course, increased concurrently, and this is the outcome, mainly, of the 'speeding up' consequent upon the limitation of hours. Besides this increase of danger, our miners have got reduced earnings, inconvenient shifts, and the loss of much week-end leisure. For example, it was the custom at many pits, before the Eight Hours Act was passed, for the men to work long shifts on mid-week days in order to have ample time for gardening and sport at the week-ends. The men frequently had clear spells of leisure from Friday night till Tuesday morning. Now, with the law limiting the working hours to eight each day, it becomes necessary for the men to be in the pits one and two shifts more per week—that is, they have to work Saturdays and Mondays in order to 'make wages.' Thus, including the time occupied getting to and from work, the average miner has less time for home life than he had before the State attempted to give him more time to himself. The Act has defeated its own chief object. At many of the pits in Northumberland, where the men have voted for a strike, and in Durham, where there is a similar movement to get back to the conditions which existed before the Eight Hours Act was passed, this measure has done immense injury to the workers. It has necessitated the introduction of what is called the 'multiple shift' system. This means that where formerly the men worked two short shifts daily—the 'fore' shift and the 'back' shift—and the boys on a regular single-shift system, the men are now on three or four shifts, extending to nearly the full twenty-four hours daily, and the boys are on a double-shift system. The result is that in households where there are three or four sons, or lodgers, as well as the father employed at the pits, and on different shifts, the workers are going out and coming in at almost all hours of the day and night; the women have scarcely ever done preparing meals and changes of clothing; the houses are always upset; evening leisure is cut down; the boys cannot attend classes; and the men have to hold their lodge meetings on Sundays. Domestic and social customs are completely disorganised, and the public health authorities already note an increase in the infantile death-rate because the women have less time to attend to their children. It may with truth be said that alike on earnings, leisure, health, and safety the Eight Hours Act has, almost everywhere, had results the very opposite of what the men were led to expect."

The Settlement of Labour Disputes. — It is pleasant to be able to note that Sir Charles Macara has received the signatures of more than twelve hundred prominent men, in commerce and industry, in support of his suggestions for the settlement of labour disputes. It is believed by the supporters of the scheme that the creation of a new department, with a competent, non-political, permanent chairman, deputy-chairman, and staff, assisted by an advisory board composed of the most prominent men, representing both capital and labour, connected with the great staple

industries, and possessed of practical experience in the settlement of disputes, would tend to the promotion of friendly settlements when the disputants have come to a deadlock. Anyway, the experiment seems to be worth trying. The scheme concerns itself with deadlocks only, and would not in any way interfere with existing organisations for dealing with labour disputes.

"*Kilometre Books.*" — The General European Agent of the national railways of Mexico, referring to a communication he made to the press in May last—in which he said that the national railways of Mexico were prepared to issue "kilometre books" to genuine commercial travellers, provided their applications were endorsed by a Mexican chamber of commerce, a privilege not at that time extended to the representatives of foreign firms, since the local chambers declined to support their requests—says that he is now in a position to advise that this disability has been removed, and the kilometre books can henceforth be issued to any identified commercial traveller. Applications should be addressed to the agent, and bear the signature of the secretary or other authorised official of any chamber of commerce of which the firm may be a member. Manufacturers will recognise the advantage of being able to secure these books, as, apart from some saving in cost over the ordinary fares, and privileges as regards conveyance of samples, a considerable amount of inconvenience and delay is avoided.

Substitutes for Cotton.—The high prices and scarcity of cotton have encouraged German manufacturers to turn their attention to the cultivation of substitutes, among them being kapok. The German Committee on Colonial Agriculture has sent representatives to the Fibre Congress, to be held in Surabaya, Java, to study the cultivation of sisal, manila, hemp, jute, and kapok. It is stated that much is expected from the cultivation of kapok and calotropis, not only in the German colonies, but also in Mexico, Brazil, and other South American States. The kapok crop for the current year is estimated at 70,000 bales. Herr Stark, of Chemnitz, has made experiments with a view to determine the possibilities of kapok, and it is said that he has succeeded in bleaching it. It is also being mixed with wool and silk waste and spun into yarn by the carded woollen process. But it will be a long time before kapok, or any other substitute, plays an important part as raw material for the manufacture of goods for which cotton has hitherto been used.

Vacuum Cleaning and Mills.—A good deal of attention has been given in recent years to the application of vacuum-cleaning to textile machinery. Ordinary hand-cleaning of this sort of machinery is necessarily laborious, and therefore expensive, owing to its complexity, but vacuum systems that have proved successful for domestic purposes are not equally so with textile machinery, owing to the nature of the dirt to be got rid of, which is mostly oily fluff. But an invention described in the *Textile World Record* is said to overcome most of the difficulties. It is a combination of the blowing and the suction systems. A powerful air-blast is used to detach the dirt, which is then collected by a low-pressure vacuum and deposited in a canvas bag. The apparatus is small, light enough to be carried by the operator down the narrow alleys between frames, is easily worked, since all that is required to change from air-blast to suction is the closing of a valve, and the motive power is economical, being obtained from the compressed air supply which works the humidifier installation. One advantage of working by compressed air is that cleaning can be done when the mill is standing. But there is said to be danger of blowing dirt on to yarn and cloth in operation.

Flax-mills and Wages.—For the first time in the history of the industry a Flax Workers' Union has been formed, and it would seem that flax workers are in need of some such body to champion them. At the present time several hundreds of women are on strike for an advance of 2*s.* a week on their wages, and the men are demanding a minimum wage of £1 a week. "Even when in full work," the officials of the council say, "it is as much as these operatives can do to keep body and soul together. The best standing wage in a week, including bonus, is 11*s.* And, as many of the women are widows with families to keep, and others have sick or out-of-work husbands or other relatives to help, there is no chance of saving; so that the instant wages cease they have nothing to draw upon." The best rate of pay appears to be a standing wage of 9*s.* 6*d.* a week, with a bonus of 1*s.* 6*d.* (forfeited if a day's work is lost). Some girls after three or four years' employment are able to earn only 5*s.* 9*d.* (bonus included), and a woman who has worked at the mill all the best years of her life draws a wage of 8*s.* 6*d.* There would seem to be ground here for a struggle for a better wage.

CORRESPONDENCE.

CANTOR LECTURES ON "ETCHING."

As Mr. Wedmore is quite unable to explain away the ignorance, prejudice, or carelessness which distinguished his Cantor Lectures, he has descended to personal abuse of me, couched in the most misleading terms, intended to injure me, if possible. His article, which he refers to, concerning my work, was not for my publishers' exhibition, as he incorrectly states—they were not giving one—but for the Grolier Club of New York; and Mr. Wedmore omits to say that his article was rejected as soon as read—it was not considered worth printing.

JOSEPH PENNELL.

3, Adelphi Terrace House, Robert Street,
Strand, London, W.C.,
September 1st, 1911.

NOTES ON BOOKS.

LES FAUVES D'AFRIQUE PHOTOGRAPHIÉS CHEZ EUX. Par Radcliffe Dugmore. Paris: Hachette. 1910.

The author of this book is presumably a Frenchman, as he writes in that language, though he has not a French name. According to his own account his previous hunting experiences have been in North America, where he abandoned the rifle for the camera. "Pendant de nombreuses années, je fus un chasseur plus enthousiaste que quiconque. Aujourd'hui, après en avoir passé dix avec la chambre noire au lieu du rifle, je n'ai pas le moindre désir de tirer des coups de feu. J'estime que ce n'est plus pour moi suffisamment émotionnant, et que cela constitue un sport trop aisé pour être intéressant." Certainly there can be no lack of excitement in a sport which requires the sportsman to spend the night in a frail shelter hut constructed on the ground, with three lions prowling and growling about ten yards off, in the hope that they will pose themselves in front of a camera, with a flashlight ready to be touched off if they do. It is much more difficult to photograph an animal than to shoot him, or at least it is more difficult to get within photographic range than gunshot range. Probably, once you are near enough, it may be easier to miss him with the gun than with the camera.

Mr. Dugmore has, of course, his predecessors. Mr. Roosevelt's party comprised an official photographer in the person of his son, who got some marvellous pictures. A German sportsman got some remarkable flashlight pictures of lions and leopards a few years ago, and a picture of a Rocky Mountain goat a few feet away adorns a volume of another American sportsman who carries a camera. But our author need not fear comparison with any of his competitors, whether with flashlight or daylight. There is certainly no better flashlight photograph of a lion (or rather lioness) than the one facing page 206. Another (facing page 86) is interesting and valuable scientifically, but pictorially not quite so perfect. Another wonderful picture is the charging rhinoceros, taken full front a few yards off, before he was turned by a bullet from the photographer's companion. There are many others worthy of mention—giraffes, buffaloes, zebras, antelopes, etc.—all taken by stalking at close quarters, and a large collection of telephotographs. They are admirably reproduced by some phototype process, being apparently slightly enlarged in some cases, though in others they look as if the prints were the same size as the original.

The author does not give us much information about his apparatus or methods. He uses both plates and films, but prefers the former. He develops at once, and takes a print on self-toning paper, in case of accident to the plate. He uses ortho-chromatic plates without a screen. He employs an electric arrangement for the simultaneous firing of the magnesium and the working of the shutter. For the photograph of the lioness above mentioned, three cameras were set up, eight or ten feet apart, and nine metres (say thirty feet) from the carcass which served as bait.

GENERAL NOTES.

PREVENTION OF MALARIA IN RICE-GROWING DISTRICTS.—As a remedy for malaria in the rice-growing districts bordering on the Po, the rearing of fish is said to have given good results. This region, which covers an area of about 200,000 hectares (nearly half a million acres), is more or less unhealthy. The young carp are turned out into the flooded fields towards the end of June, and greedily devour the larvæ of the insect life which appear to be a cause of the disease. The cost of the young fish does not exceed 4 to 5 francs per hectare (1*s.* 4*d.* to 1*s.* 9*d.* per acre). It is stated also that the crops are improved by the rearing of the carp to the extent of 4 to 5 quintals of rice per hectare (2 to 2½ cwts. per acre).

CANADIAN OYSTER-BEDS.—According to a recent official report for 1910, the oyster-beds of the Maritime Provinces are very seriously depleted, and many are entirely non-productive. The natural live oyster-beds of New Brunswick, Prince Edward Island and Nova Scotia are yet, however, of considerable value, while much ground is available for profitable private culture. It has been recommended that the Dominion Government appropriate sufficient money to establish new, and restock exhausted, beds, either by natural or artificial means, and that liberal inducements be offered through a system of leases to persons who will undertake, under stringent regulations, to engage in the oyster business. It is claimed that many of the oyster-beds of Prince Edward Island have been destroyed by farmers, who have sought what is called mussel mud to place on their land to supply the lack of lime in the soil. This is now regulated by law, and no mussel mud can be taken within 200 feet of a live oyster-bed. The mud is collected by means of a horse-drawn scoop worked through holes in the ice. Thousands of loads have thus been taken and placed upon the land.

SHIPBUILDING ACTIVITY IN ITALY.—According to a recent report to the shareholders of Ansaldo, Armstrong and Company, of Genoa, the shipbuilding industry appears to be in a flourishing condition in Italy at the present time. Amongst the principal works which this firm have on hand for the Italian navy are the ironclad "Giulio Cesare," now on the stocks at their Sestri Ponente yard, for which they will supply the turbines as well as the guns. This firm are also constructing the turbine machinery for four other vessels, viz., the cruisers "Dante Alighieri," "Leonardo da Vinci," "Conte

di Cavour," and "Quarto," which are being built by other firms. Last year they built six torpedo-catchers, and supplied the turbines for the cruiser "San Marco." Besides this work for the navy, the turbine passenger steamer, the "Città di Catania," was built and launched by the same firm, who also supplied the turbines for another passenger vessel, the "Città di Palermo," built elsewhere. Amongst other vessels now in construction may be mentioned a torpedo-catcher for the Chilian Government, and a cruiser for the Ottoman navy, not to speak of tugs and other smaller craft. At the Sampierdarena works the same firm completed sixty-three locomotives last year, and have on hand orders for fifty-eight more at the present time.

Locomotive Construction in Italy.—The administration of the Italian State Railways has lately placed contracts for constructing 193 locomotive engines at prices ranging from 1·64 to 1·75 lire per kilogramme for the engines, and at 90 centimes for tenders. Taking the English ton at 1,016 kilogrammes, these prices would correspond to from £66 13*s.* to £71 2*s.* 5*d.* per ton for the engines, and £36 11*s.* 6*d.* per ton for the tenders. Eighty-one locomotives are to be built at Milan, 60 at Sampierdarena, near Genoa, 32 at Naples, and 20 at Saronno (Lombardy), and are to be delivered in the course of the present year.

Proposed Railway under Lagoon at Venice.—It is now proposed to connect Venice with the island of Lido by a tunnel under the lagoon. This island, a favourite summer resort of the Venetians on account of its unrivalled beach and excellent sea-bathing, is situated on the Adriatic about two miles from the city. The terminus of the line would be in a central position, close to the Piazza di San Marco, and the Riva degli Schiavoni, at about 8 metres (26¼ ft.) below the sea level. The tunnel, 3,600 metres (2¼ miles) in length, would pass in a straight line, under the islands of La Giudecca and San Georgio, to the terminus of Lido, at a spot called the Quattro Fontane. The line and lifts would be worked by electricity, and frequent trains could perform the journey in five minutes.

Cure for Mildew of the Vine.—Many remedies have been tried against the ravages of the various insects and fungus pests, which of late years have devastated the vineyards of France and Italy. The opinion of winegrowers in both these countries is much divided as to the value of the various preparations advocated for the purpose. The poisonous nature of the arsenical salts which enter into the composition of many of these is a serious objection to their adoption. Nicotine, on the other hand, though efficient, in many cases, is not altogether harmless to the person using it, and is liable to cause intoxication in some cases. In many parts of France, "Lysol" has proved a most valuable panacea, when used with a solution of sulphate of copper and lime-water, for spraying the leaves and grapes. The proportion of "lysol" used for the first treatment of the vines is half a litre per 100 litres (about 1 pint to 22 gallons) of solution, which should be well mixed. For subsequent treatments the proportion of "lysol" should be doubled. Care must be taken to spray every part of the leaves and grapes with the solution.

Peridot Stones of Ancient Egypt.—A deposit of "peridots" has recently been discovered in Alexandria. These stones, which are amber in colour, for many years have been found in large quantities in Upper Egypt. The finder has secured a concession to work the ground, and has uncovered several thousands of these stones at a depth not greater than ten feet. It is believed that the peridots were buried in the foundations of houses of the ancient Egyptians, and in tombs, as an omen of luck. The stones now found are estimated to have been buried for over 1,500 years. Their value is not great, the price of the stone of the average weight of three carats being a little over four shillings. The discoverers of the Alexandria deposits have also secured a concession to work ground on the islands of Rahamah and Kad-Ali near Assab, in Red Sea territory belonging to Italy. Some peridots have recently been found there, and it is believed that the deposit is a large one never before mined.

Importation of Autocars to England.—Judging from a French journal, England appears to be, by far, the largest importer of autocars of any other nations. In 1910 she imported to the value of 141,945,000 francs (£5,677,800), or more than ten times that imported by the United States, which amounted to 13,686,000 francs (£547,440), whilst the value of the cars imported to Germany reached 12,285,000 francs (£491,400); to France, 9,320,000 francs (£378,800), and to Italy, 5,120,000 francs (£204,800).

Population of Messina.—It may come as a surprise to many to learn that, according to the general census made throughout Italy last spring, the population of Messina is now 123,689. The number of inhabitants of that city before the disastrous earthquake at the end of 1908 was upwards of 172,000.

German Revenue-Producing Administrations.—Some interesting information is given by Count de Salis, Councillor of His Majesty's Embassy at Berlin, in his report just published (No. 4626 Annual Series) on the finances of the German Empire touching property owned by the State in Prussia. The domains include a large quantity of agricultural land, part of which is let, while the rest is managed by State officials. They also include mineral-water springs and baths, which bring in more than £100,000 a year. The sale of timber from the State forests brings in nearly £6,000,000. Coal brings in more than £9,000,000, and the combined sale of iron, silver, and lead over

£1,000,000. The State also owns extensive potash works, and is accordingly a member of the Syndicate which has the exclusive right of carrying on the potash trade in Prussia. The State owns 32,000 kilometres of railway out of a total of 34,000 kilometres. The small amount owned by private companies comprises almost entirely what are known as secondary railways. The total capital outlay on railways in Germany up to 1907 is officially estimated at 781,000,000 marks. The Prussian railways represent an investment of over 400,000,000 marks. The State derives a net revenue of nearly £500,000 from the State lottery. Under present arrangements there are two lotteries in the year, the profits of the State being derived from a deduction of 15½ per cent. from the sums distributed as winnings. The celebrated China manufactory at Charlottenburg, founded by Frederick the Great, would appear to be carried on rather for the encouragement of art than for purposes of earning revenue.

Protection of Crops from Hail.—The damage to the crops in France from hail is estimated at 150 millions of francs (six millions sterling) every year. Many remedies have been tried, with more or less degree of success, in order to mitigate the evil, not only in that country, but also in Italy and Austria. The principal means adopted for the purpose during the last ten years has been the discharge of explosives during storms in the immediate vicinity of the crops threatened. In many parts of France, and more particularly in the wine-growing departments, associations of the landowners and cultivators have been formed for the mutual protection of their vineyards. In the Beaujolais district last year, no fewer than twenty-three of these societies were in existence; they are provided with 387 cannons or mortars. In another part of the same district, but separated by a considerable extent of unprotected country, there are six other societies with 137 stations for the discharge of rockets. These two groups form the "Union des Associations Grêlifuges du Beaujolais," and carry out their operations during storms on a preconcerted plan. In this district there are also several independent associations for *tirs contre la grêle.* The results obtained by these means of defence have, on the whole, been satisfactory in France, where public opinion is more unanimous as to its efficacy than is the case in Italy. The immediate effects of the discharge of explosives, either from cannon, mortar, or by means of a firework (*fusée*), is said to be to abate the thunder and lightning, to stop the wind, and to melt the hailstones before they can reach the ground or injure the plants.

Motor-car Trade in Egypt.—The total value of the motor-cars imported in 1910 by Egypt amounted to 968,150 francs (£38,726). Of this amount, about two-thirds were paid for cars of French make, whilst England figures for 191,700 francs (£76,680), or about one-fifth of the total value.

Chinese Industrial Development.—In his report on the trade of China just issued, Mr. H. H. Fox, Acting Commercial Attaché to his Majesty's Legation at Peking, refers to that industrial awakening of the Chinese people which has been so noticeable during the past decade, and which must, sooner or later, alter the character of their commercial relations with foreign countries. Mr. Fox does not think that this movement need cause us serious anxiety, for the present at any rate. In his opinion Chinese factories will be unable for some time to come to turn out any but low-grade articles, which will only compete with Japanese productions of a similar class. The finer qualities of goods for which the spread of Western civilization is bringing an increasing demand, will continue to come from abroad. Moreover, the general use of foreign goods in China is still confined to the towns and districts situated on the coast or along the great rivers, although before long railways will open up vast areas where at present foreign goods are practically unknown. A factor which militates against the success of Chinese industrial undertakings is their dislike of employing foreign managers and engineers. "Just as in their schools and colleges, the Chinese are endeavouring to assimilate Western languages and sciences by means of native professors who themselves possess no more than a smattering of the subjects they teach, so in factories, when they have laid down at great expense an up-to-date plant of complicated and delicate machinery, they dispense with the foreign expert almost as soon as the machines have started working, leaving them to the tender mercies of native engineers, who are helpless so soon as anything goes wrong." And as on the technical, so on the commercial side of the undertaking. The Chinese are not yet capable of conducting large commercial enterprises, such as steamship companies, iron works, etc., on good business lines, and their promoters deliberately refuse to avail themselves of foreign business knowledge and experience.

The Queensland Timber Industry.—The forest resources of Queensland are extensive, amounting to 40,000,000 acres, or 9·32 per cent. of the whole area of the State, while 3,836,191 acres, or 0·89 per cent. are specially reserved by the Government for timber. The forests of Queensland yield a great variety of woods noted for strength, durability, and beauty. The eucalyptus dominates the forests, which also contain iron bark, grey, spotted, and red gum, black butt and turpentine. The conifers, too, are numerous, including Moreton bay and brown, and bunya-bunya pines. Among the brush timbers of fine grain are red cedar, beach, tulip wood, and rosewood. In the extensive plateaus west of the dividing range off from the coast there is but little timber, and in the vast basin of the interior usually only stunted eucalyptus are found. The quantity of timber cut and sawn in Queensland in the latest year for which the particulars are available was 100,760,000 superficial feet, valued at £660,000.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

INDIAN SECTION.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

BREWING AND MODERN SCIENCE.

By Professor Adrian J. Brown, F.R.S.

Lecture IV.—Delivered February 27th, 1911.

THE FERMENTATION PROCESS.

Although no course of Cantor Lectures on brewing has been given since Dr. Graham lectured on the subject in 1873, fermentation, a subject most intimately associated with brewing, has been discussed on several occasions. In 1884 Professor Hartley gave a series of lectures on "Fermentation and Distillation." In 1888 Mr. A. Gordon Salamon gave a course of lectures on "Yeast: its Morphology and Culture," in which he reviewed in a very able manner those investigations of the late Dr. E. C. Hansen, of Copenhagen, in connection with yeast, which have exerted such an important influence on the brewing industry throughout the world. Again, in 1892, a course of lectures on the "Chemistry and Bacteriology of the Fermentation Industries" was given by Professor Percy Frankland—a more able exponent of these subjects could not be found.

As, therefore, the subject of fermentation has already been discussed from several different points of view since it was referred to in Dr. Graham's lectures on brewing thirty-eight years ago, I feel that general reference to the subject now is unnecessary. In the time at my disposal, I think it will be better for me to confine my remarks to certain questions in connection with fermentation on which much light has been thrown by recent investigations, and which are of special importance at the present time.

Since the time when that most illustrious man, Pasteur, demonstrated to the world at large that fermentation was a phenomenon

directly associated with cell-life, our views regarding the more precise nature of the phenomenon have experienced marked changes. Probably every one in this room is more or less familiar with the reasons which guided Pasteur, during his study of fermentation, to formulate a theory regarding its prime cause, which was accepted almost universally until quite recent times.

During Pasteur's remarkable investigations, a very striking discovery made in connection with yeast was that this micro-organism was able to grow and lead an active life in an environment deprived of air, or free oxygen. Hitherto the belief had been universal that air was necessary for life, that life perhaps might be able to persist in a dormant condition for a time without air, but that the presence of air was essential for the production of vital energy. Pasteur's investigations demonstrated, however, that a previously unrecognised condition of existence—anaerobic life—was possible. Now this most interesting and striking discovery was made with regard to an organism which was conspicuous for its fermentative power, and the association of anaerobic existence and fermentation in the one organism very naturally suggested to Pasteur that perhaps the two phenomena were interdependent.

When studying the growth and actions of yeast in a fermentable liquid such as malt-wort, Pasteur noticed when yeast was introduced into aerated wort that the whole of the oxygen dissolved in the liquid was very rapidly absorbed by the yeast, and at the same time active multiplication of the yeast-cells by budding took place. Subsequently, when the yeast was under anaerobic conditions, active fermentation of the sugar of the wort was evidenced, and multiplication of the yeast-cells became less rapid and finally ceased altogether. From observations such as these Pasteur was led to regard yeast as an organism endowed with two modes of life—in the presence of air he considered that it lived the life of an ordinary fungus and exhibited the usual actions of cell-life; in the absence of air he believed it took on the new properties of a ferment, and was enabled to ferment sugar. In Pasteur's well-known "Études sur la Bière," a series of most beautiful experiments with yeast under aerobic and anaerobic conditions are described which seemed to confirm this view. Moreover, when Pasteur's investigations were extended to fermentation phenomena other than those occasioned by yeast, the view that the phenomenon of fermentation was the result of anaerobic existence appeared to obtain additional confirmation. In the case of certain lactic and butyric acid-producing bacteria it was shown that the fermentation changes induced by these organisms appeared to depend on the conditions of their existence being anaerobic.

From evidence such as that to which I have very briefly referred, Pasteur was led to formulate his well-known and beautiful theory that the phenomenon of fermentation was a direct consequence of "life without air"—that is to say, that the chemical changes we know as fermentation were the result of vital activity in the absence of free oxygen.

Decomposition of fermentable matter was, according to Pasteur's view, occasioned by organisms living under anaerobic conditions and abstracting the oxygen which was presumed to be necessary for their existence from the fermentable matter. In the case of the fermentation of sugar by yeast, it was known that in addition to the main products of fermentation —alcohol and carbon-dioxide—small quantities of glycerine and succinic acid are produced, and it was suggested that these products might result directly from the removal of oxygen from a small quantity of sugar in the following manner

$$8\ C_6H_{12}O_6 + 6\ H_2O = \underset{\text{Succinic acid}}{2\ C_4H_6O_4} + \underset{\text{Glycerine}}{12\ C_3H_8O_3} + 4\ CO_2 + O_2.$$

As a consequence of this reaction, it was supposed that it further occasioned the splitting up of a very much larger amount of sugar into alcohol and carbon-dioxide, so producing the ordinary phenomena associated with alcoholic fermentation.

Pasteur's theory regarding the connection of fermentation with anaerobic life was very generally accepted for many years. In the year 1892, however, during the course of an investigation connected with the reproduction of yeast, I obtained results which led me to question its validity. In the experiments made by Pasteur to determine the relative fermentative power of yeast under anaerobic and aerobic conditions, complications arose through the reproduction and consequent increase in number of the yeast-cells during the course of the experiments. My investigations of the specific character of the reproduction of yeast-cells by budding demonstrated that when yeast is introduced into a fermentable nutritive solution, such as malt-wort, the cells have a tendency to increase to a definite number in a given volume

of the liquid and then to cease reproducing. This property of the cells is independent of the amount of the food-supply in the fermentable liquid so long as it is kept within certain limits, and is also independent of the number of cells originally introduced into the fermentable liquid so long as the number added does not exceed the maximum number to which the cells naturally increase under normal conditions in the fermentable solution employed. If, on the other hand, a larger number of cells than the maximum is introduced into the liquid, then little or no multiplication of the cells is observed. Hence it appeared that experiments on the fermentative power of yeast could be conducted with a constant number of yeast-cells if the number of cells employed exceeded a certain maximum number.

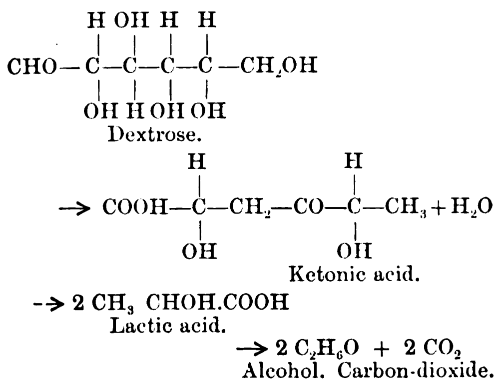
Experiments based on this conclusion were made in which the fermentative powers of equal and constant amounts of yeast under aerobic and anaerobic conditions were measured. I confess, when these experiments were commenced, I was happy in the idea that I had found a very easy means of demonstrating the truth of Pasteur's beautiful theory of fermentation. Great, therefore, was my surprise when I found that the results of my experiments pointed to the conclusion that aerobic existence did not hinder fermentation. After conducting experiments in the most suitable manner I could devise in order to obtain the most complete aeration possible, so far from finding that a supply of free oxygen arrested the fermentative power of yeast, as it should according to Pasteur's theory, it tended somewhat in the direction of stimulating it. Notwithstanding Pasteur's powerful arguments, I was forced to the conclusion that his theory, as ordinarily understood, could not be upheld, and I felt compelled to express this view; but it was much against my will, for the eminent author of the theory was approaching the end of his illustrious career, and was no longer in a position to defend his own views. However, his lieutenant, M. Duclaux, most ably criticised my investigations, and probably the subject would have passed through other developments had it not been for the confirmation my views received from another source, which rendered further investigation on my part unnecessary. I refer to Buchner's discovery that zymase, an enzyme present in the yeast-cell, was the direct cause of its fermentative power.

Hitherto, fermentation of sugar by yeast had been regarded in a somewhat undeterminative manner as an action of the living protoplasm of the cell; this view was a survival from earlier days, when many changes which we now recognise as purely chemical were attributed to the direct action of life, for want of better knowledge. It appears natural to humanity, past and present, when the unknown is encountered to refer it, by way of explanation, to some still more mysterious unknown; we all seem tempted to do it, either through laziness or conceit, possibly through both. However this may be, increasing knowledge, as it gradually throws light on the physiological processes of life, tends to demonstrate that all the phenomena of life may be the outcome of ordinary chemical action. Previous to Buchner's discovery, knowledge of enzymes had been increasing, and many, so-called, fermentation changes had already been traced to their agency; but alcoholic fermentation of sugar, lying secure, as it appeared, under the protection of Pasteur's theory, seemed to be directly brought about by the action of living protoplasm until Buchner demonstrated that it, too, was the work of an enzyme present in the living yeast-cell.

No doubt, it remains in the recollection of most of my audience how this was demonstrated. In the first instance, Buchner separated the fluid contents of yeast-cells by grinding the cells with sand and infusorial earth and subsequently submitting the ground mass to very great pressure. The separated cell-juice obtained in this manner, when mixed with cane-sugar, was then found to possess the power of fermenting the sugar to alcohol and carbon-dioxide. Buchner's earlier experiments conducted in this manner were open to the criticism that residual vitality, persisting in the expressed protoplasmic matter of the cells, might perhaps effect the observed fermentation. But subsequent investigation proved that this was not so. It was found that yeast-juice can be dried without losing its fermentative power; it will also carry on fermentation in the presence of antiseptic agents which are inimical to life. Like most other enzymes also, zymase can be precipitated from yeast-juice by alcohol and still retain its power of fermenting sugar. It is unquestionable that Buchner's investigations definitely prove that the fermentative property of the yeast-cell is not directly due to vital activity, but to the activity of an enzyme—the so-called zymase—which exists within the cell. Moreover, Buchner's experiments also demonstrate that air or oxygen exerts no influence on the fermentative action of zymase. So Pasteur's noted theory that

fermentation is the effect of "life without air," can be, in its ordinary meaning, no longer upheld.

Buchner, continuing his investigations, was led to formulate the idea that alcoholic fermentation is not effected by a single enzyme breaking down sugar directly to alcohol and carbon-dioxide, but to the action of two enzymes working in conjunction, one which transforms sugar to lactic acid, and another which decomposes the lactic acid previously formed into alcohol and carbon-dioxide. The formation of lactic acid from sugar by the first enzyme was brought about, he supposed, by the sugar molecule passing through a transitional stage in which a hypothetical di-hydroxy-γ' ketonic acid was produced in some such way as is represented by the following expression



Subsequently the second enzyme was supposed to break down the lactic acid molecule to alcohol and carbon-dioxide as represented above. But the more recent investigations of Harden and Slator throw very great doubt on the view that lactic acid is formed as a transition product during alcoholic fermentation, and I believe Buchner himself no longer holds this view.

The present most interesting position with regard to our knowledge of the enzymic changes which take place during alcoholic fermentation has been reached through the remarkable investigations of Harden and his colleagues of the Lister Institute.

During a study of the properties of expressed yeast-juice prepared from yeast by Buchner's method, it was found, when the juice was subjected to rapid filtration through a Chamberland filter impregnated with gelatin, that something passed through the filter—and a residue was left behind which was no longer able to ferment sugar. On the other hand, when the portion which passed through the filter was examined, it was discovered that it also was incapable of fermenting sugar. So it was found possible to separate yeast-juice possessing active fermentative power into two parts by filtration, neither portion of which possessed fermentative power. When, however, the two portions were again united it was found that the lost power of fermentation was recovered. It became evident, therefore, that alcoholic fermentation depends on the conjunction of at least two agents—an enzyme and a so-called co-enzyme. The inactive material which does not pass through the filter, and which is coagulated and rendered powerless by heat, is regarded as the enzyme. The material which passes through the filter, and which, after heating to the boiling point, still possesses the power of activating the residue, is called the co-enzyme. Together, these two agents possess the property of fermenting sugar—apart they are both inactive.

During the fermentation of sugar with yeast-juice containing the enzyme and co-enzyme, as fermentation proceeds it was found that both these materials gradually disappear. It appears very probable that destruction of the enzyme is effected by the direct influence of the proteoclastic enzymes present in the yeast-juice; but apparently this is not the case with the co-enzyme. There is reason to believe that destruction of the co-enzyme is effected by lipase, an enzyme present in yeast-juice which decomposes fats into glycerol and fatty acids; under these circumstances, therefore, it appears possible that the chemical nature of the somewhat mysterious co-enzyme may be allied to that of the fats, but at present this should be regarded with doubt. In connection with the question of the destruction of the enzyme and co-enzyme in yeast-juice on keeping, it is interesting to note that the manner in which this takes place differs to some extent with the type of yeast from which the juice is derived. For instance, Buchner has obtained a juice from German bottom-fermentation yeast in which the co-enzyme dies out regularly before the enzyme. On the other hand, with yeast-juice derived from English top yeasts Harden finds that the enzyme and the co-enzyme are inclined to die out together.

Harden's studies of the influence of phosphates on the decomposition of sugar by yeast-juice, have also brought into prominence subjects of the greatest importance in connection with our knowledge of fermentation. When boiled yeast-juice, or a boiled solution of filtered co-enzyme is added to a fermenting

mixture of ordinary yeast-juice and sugar, a very marked increase in evolution of carbon-dioxide is evidenced in the first fifteen minutes after addition, and subsequently evolution of gas declines to its original velocity. This marked and transient rise in velocity of fermentation has been traced to the presence of phosphates in the boiled extracts employed. When phosphate of sodium or potassium was added to a mixture of yeast-juice and sugar it was found that a rapid increase in the evolution of carbon-dioxide takes place. Moreover, it was found that the phosphate acted in the manner of a chemical reagent, because the carbon-dioxide liberated is exactly equivalent to the amount of phosphate added—a molecular proportion of phosphate liberates a molecular proportion of carbon-dioxide. Further, if after addition of a phosphate to yeast-juice and sugar its equivalent of carbon-dioxide has been liberated and the fermentation rate has sunk to its normal velocity, it was found that a further addition of phosphate caused another rapid disengagement of gas, and that this condition could be repeated many times.

The next step in Harden's investigations was to ascertain what becomes of the phosphate after its addition to yeast-juice. After boiling yeast-juice mixed with phosphate, and adding "magnesia mixture" in the usual manner employed in chemical analysis to precipitate phosphoric acid, it was found that the phosphate present was no longer precipitable by the reagent—evidently it was no longer in the form of mineral phosphate, but in some other form. Further study led to the isolation from yeast-juice to which phosphate had been added, of a new compound apparently composed of a sugar (hexose) residue and phosphoric acid, to which the name "hexosephosphate" has been given. At present there is some difference of opinion with regard to the exact chemical structure of this compound, but Harden and Young consider it is formed from a combination of one molecule of hexose with two molecules of phosphate, and results in hexosephosphate possessing the formula $C_6H_{10}O_4\ (PO_4H_2)_2$. Assuming that this view is correct, Harden explains the action of phosphates when added to a fermenting mixture of yeast-juice and sugar in the following manner, presupposing of course that the action only takes place in the presence of the enzyme and co-enzyme of yeast. When the phosphate is first added, one molecule of sugar breaks down into carbon-dioxide and alcohol, and a second molecule combines with the phosphate and forms the hexosephosphate compound as represented in the following equation

$$2C_6H_{12}O_6 + 2Na_2HPO_4$$
$$= 2CO_2 + 2C_2H_6O + 2H_2O + C_6H_{10}O_4\ (PO_4Na_2)_2.$$

Whether two distinct molecules of sugar contribute, the one to the formation of hexosephosphate, and the other to the formation of carbon-dioxide and alcohol—or two fragments derived from the two different molecules of sugar unite and form hexosephosphate, has not yet been determined; but to some extent the latter view is strengthened by the extremely interesting observation that when the hexosephosphate derived from dextrose is hydrolysed by boiling with acid, dextrose is not the sugar recovered, but in the main it consists of levulose. Exactly the same observation has been made also with hexosephosphate prepared from the sugar mannose—on hydrolysing this compound, levulose is the chief product obtained.

But at present no attempt has been made to explain the complete *rôle* of phosphates during ordinary fermentation of sugar by yeast-juice. As already implied, Harden considers that the presence of free phosphate is necessary for the production of fermentation by the joint action of enzyme and co-enzyme. But, as we have already seen, after a limited time the whole of the phosphate present becomes converted into hexosephosphate, in which combination it is apparently inert. How are we, therefore, to account for the well-known regular and prolonged fermentation which proceeds when yeast-juice is in contact with sugar, if all the phosphate present becomes fixed as hexosephosphate and remains inactive? Harden finds an explanation in the presence of an enzyme in yeast-juice named hexosephosphatase, which is capable of hydrolysing the hexosephosphate into free sugar and free phosphate. The enzyme is supposed to bring about this change according to the following equation

$$C_6H_{10}O_4\ (PO_4Na_2)_2 + 2H_2O$$
$$= C_6H_{12}O_6 + 2Na_2HPO_4.$$

Consequently it follows that if the fermentation of sugar by yeast-juice proceeds in molecular proportion with the free phosphate present, that the rate at which the enzyme hexosephosphatase decomposes the hexosephosphate present, determines the normal velocity of fermentation induced by yeast-juice.

When Harden was studying the action of phosphates on fermentation, the remarkable influence they exerted naturally led him to examine the influence of arsenates, salts which

possess a somewhat close chemical relationship to phosphates.

He found, when sodium arsenate was added to a fermenting mixture of yeast-juice and sugar, that the velocity of fermentation was considerably accelerated in somewhat the same manner as if sodium phosphate had been employed. But a very marked difference observed in the case of arsenates was that no definite equivalent of carbon-dioxide was evolved during fermentation as with phosphates, and a much larger volume of gas was liberated; acceleration in the rate of fermentation also continued for a much longer period of time with sodium arsenate as compared with sodium phosphate. From these points of difference and others, Harden has arrived at the conclusion that arsenates do not take the place of phosphates chemically, but that they act in quite a different manner by stimulating the action of the enzyme, hexosephosphatase, which hydrolyses the hexosephosphate.

We have already seen in the case of yeast-juice that the velocity with which the enzyme hexosephosphatase decomposes the hexosephosphate determines the velocity with which the juice decomposes sugar. Harden considers it very probable that in the case of the living yeast-cell velocity of fermentation is controlled by the same influence, and that the main difference between the very active fermentation evidenced by living yeast-cells, as compared with the much slower action of yeast-juice, is governed by the rate at which the phosphate present goes through its cycle of change. The enzyme hexosephosphatase in its natural position, or state, within the living cell, appears to act with a much higher velocity on the hexosephosphate than when it exists in a disorganised condition in expressed yeast-juice. This is a condition which seems very likely to occur if one recognises how expression of the juice from crushed yeast-cells must mingle the enzymes present in the cells, which otherwise probably exist apart in living protoplasm within their own proper sphere of action. There are good reasons to believe that living protoplasm possesses some form of anatomy, although at present little is known about it.

With regard to the velocity of fermentation by living yeast-cells, Harden mentions that if the amount of phosphorus present in a yeast-cell and its velocity of fermentation are known, it is possible, according to the hypothesis of the transformation of hexosephosphate just mentioned, to calculate the number of times that the phosphorus of the yeast-cell must go through its cycle of change in order to produce the observed rate of fermentation. In the case of a cell of ordinary brewer's yeast fermenting sugar at 25° C., it has been determined that the whole of its phosphorus goes through this cycle twice in every five minutes.

I have mentioned before that Buchner's hypothesis regarding the formation of lactic acid from sugar as an intermediate product of alcoholic fermentation has been abandoned owing to the results of recent investigations. On the other hand, it is now supposed by some investigators that dihydroxyacetone, $CH_2OH.CO.CH_2OH$, may be an intermediate product. The evidence in favour of this is by no means convincing, but it appears very probable that a large molecule like that of glucose may break down through several stages before it is finally dissociated into alcohol and carbon-dioxide, and the possibility of dihydroxyacetone representing one of these stages is rendered more likely by the fact that glycerol is always formed in small quantity during fermentation both by living yeast-cells and yeast-juice. The formation of glycerol has never been satisfactorily accounted for, and it may well be that it takes its origin from a reduction of dihydroxyacetone

$$CH_2HO.CO.CH_2HO + H_2 = CH_2HO.CH.HO\ CH_2HO.$$

To sum up with regard to the present position of knowledge concerning the nature of fermentation. Alcoholic fermentation appears to be associated with the influence of an enzyme and a co-enzyme acting in unison on a molecular aggregation of hexose and phosphate—one-half of the hexose is decomposed into alcohol and carbon-dioxide, and the other half combines with the phosphate forming hexosephosphate, so removing the phosphate, for the time being, from the sphere of action. An enzyme, hexosephosphatase, then comes into action and hydrolyses the hexosephosphate to free phosphate and free sugar, and the cycle of change is then in a position to be again resumed.

Complex as this view of the action of fermentation appears to be, doubtless still more complex inner changes proceed during disruption of the sugar molecule into alcohol and carbon-dioxide, and many points of interest are open to future investigators before the fascinating problem is finally solved.

Before I leave this part of my subject I should like again to refer to Pasteur's original conception that fermentation is the direct result of "life without air." We have already seen that

this theory, regarded in the light of its ordinary meaning, can no longer be accepted. But if the theory is viewed in a broader sense, there is reason to believe that fermentation as a function of life may have originated from the needs of anaerobic existence. Energy necessary for the exhibition of protoplasmic activity is, in the case of ordinary air-breathing animals and plants, derived from exothermic oxidation change, or, in other words, ordinary combustion. Energy obtained in this manner was regarded as essential for the exhibition of vitality, until Pasteur pointed out that anaerobic existence was possible in the case of certain micro-organisms. How do these organisms obtain the energy necessary for their vital activity? All anaerobic organisms appear to exert fermentation changes of some kind, and all fermentation changes at present recognised are exothermic. Taking the alcoholic fermentation of sugar by yeast as an instance, it is well known, both to the technical brewer and the scientific investigator, that a very considerable amount of heat or energy is liberated during disruption of the sugar molecule into alcohol and carbon-dioxide. Presumably anaerobic yeast is capable of utilising some portion of this energy and of supporting its vital activity in this way. There is no reason apparent why energy necessary for life must be derived from direct oxidation changes, although it is usually obtained in this way. Carbohydrates, so abundantly produced by vegetable life in nature, provide a source from which energy can be obtained without the direct intervention of free oxygen if their large molecules are dissociated into smaller ones in the manner we recognise as fermentation. Is it not likely, therefore, during the course of evolution, when life appears to have adjusted itself to so many widely different conditions of being, that anaerobic life and fermentative power may together have come into existence to utilise, so to speak, the energy available in the carbohydrate molecule without the intervention of free oxygen? In this sense Pasteur's beautiful theory associating anaerobic life with fermentation may perhaps still hold good.

The origin of certain so-called secondary products of fermentation which are formed during the fermentation of sugar by yeast is a question of very considerable importance which has given rise to much discussion during past years. It has been recognised for a long time that small amounts of the higher homologues of ethyl-alcohol, such as propyl, butyl and amyl alcohols, are constantly present among the products of alcoholic fermentation, and exert an important influence on the flavour of alcoholic beverages. The quantity is always very small as compared with the ethyl alcohol produced, and the nature of the alcohols formed varies with different conditions of fermentation; but traces of some of the higher alcohols appear to be always produced during the decomposition of sugar by yeast. For many years it was considered that the source of these alcohols might be traced, not to the action of yeast during fermentation, but to the action of certain bacteria contaminating the yeast and fermenting sugar in conjunction with the yeast. In support of this view the well-known production of higher alcohols, or "fusel oil" in distillery fermentations, which are usually much contaminated with growths of bacteria and similar micro-organisms, was often quoted. This view, however, was not supported by experiment, and the question was an unsolved problem, until Ehrlich, a few years ago, demonstrated that production of the higher alcohols during fermentation originated from the action of yeast on amino acids ordinarily present in fermentable liquids. Ehrlich has shown that yeast, acting on certain amino acids, is capable of breaking them down to alcohols corresponding to the next lower acids of the series to which they belong. For instance, leucine, possessing five carbon atoms, yields amyl alcohol, possessing four carbon atoms, thus

$$\begin{matrix} CH_3 \\ CH_3 \end{matrix}\!\!>\!CH.CH_2.CH(NH_2).COOH$$

Leucine.

$$\rightarrow \begin{matrix} CH_3 \\ CH_3 \end{matrix}\!\!>\!CH.CH_2.CH_2OH.$$

Amyl alcohol.

The action of yeast under suitable conditions on other amino acids such as tyrosin, phenyl-alanine, phenylamino-acetic acid, serin, and à amino methyl butyric acid, results in every case in the expected lower alcohol being formed. The action, therefore, appears to be of a general nature, and thoroughly explains the varying quantity and character of the higher alcohols formed during alcoholic fermentation. These will evidently depend on the quantity and nature of the amino acids present, which in themselves vary with the character of the malt or other materials employed in the production of the fermentable solution.

With regard to the mechanism of this interesting action of yeast on amino acids, Ehrlich puts forward the following view:—

The NH_2 group of the amino acid is first hydrolysed under the influence of some dis-aminating enzyme, with the consequent formation of the corresponding hydroxy acid. The ammonia formed is assimilated by the yeast, and probably employed for the construction of protein matter. At the same time the hydroxy acid is subjected to what may be the ordinary zymatic action of the yeast, which dissociates it into the corresponding next lower alcohol of the series and carbon dioxide.

These actions may be, perhaps, represented as follows

$$\begin{matrix} CH_3 \\ CH_3 \end{matrix} \!\!>\! CH.CH_2.CH(NH_2)COOH + OH_2$$
Leucine.

$$\rightarrow \begin{matrix} CH_3 \\ CH_3 \end{matrix} \!\!>\! CH.CH_2.CH(OH).COOH + NH_3$$
Isobutyl ά hydroxy acetic acid. Assimilated by yeast.

$$\rightarrow \begin{matrix} CH_3 \\ CH_3 \end{matrix} \!\!>\! CH.CH_2.CH_2(OH) + CO_2$$
Amyl alcohol.

It has been definitely proved that yeast is capable of assimilating the nitrogen necessary for its nutrition from amino acids such as leucine, and this tends to confirm the view regarding the formation of the higher alcohols during ordinary alcoholic fermentation, to which I have just referred. This view also receives support from investigations of J. Effront which indicate that yeast-cells contain an enzyme "amidase" capable of liberating the nitrogen of amino acids in the form of ammonia. Effront has succeeded in demonstrating that yeast in an alkaline medium liberates ammonia from asparagin, aspartic acid, leucine, and glutaminic acid, and his conclusions have been confirmed in my own laboratory.

Another secondary product of alcoholic fermentation, succinic acid, always present in small but variable amounts among the products of fermentation of sugar by yeast, has also been shown quite recently by Ehrlich to be derived from an amino acid. In this case, however, its source is not a mono-basic amino acid, but a di-basic one, glutaminic acid. The action by which succinic acid is formed, like that by which alcohols are formed from the mono-basic amino acids, probably commences in the first instance through the dis-aminating action of the yeast, but the subsequent changes which take place are at present not properly understood.

According to the general equation representing the action of yeast on amino acids, one would expect to see γ' oxybutyric acid and not succinic acid formed during the dis-aminating action of yeast on glutaminic acid thus

$$CO.OH.CH_2.CH_2.CH(NH_2).CO.OH + H_2O$$
Glutaminic acid

$$= COOH.CH_2.CH_2.CH_2OH + NH_3 + CO_2$$
γ' oxybutyric acid.

Instead of this reaction, however, succinic acid is produced and the formation of oxybutyric acid is not recognised. Possibly oxybutyric acid may be formed and at once oxidised in the following manner

$$CO.OH.CH_2.CH_2.CH_2OH + O_2$$
γ' oxybutyric acid.

$$= CO.OH.CH_2CH_2.CO.OH. + H_2O$$
Succinic acid.

At present, however, although such a reaction seems possible, no physiological oxidation is known which is analogous, and the question is one of very many in connection with fermentation which remains for the future to answer.

A question of supreme technical importance which frequently demands the attention of the brewer, relates to the healthy development of his yeast during the fermentation process—a condition on which much depends with regard to the character of the beer he produces. So-called "yeast weakness," evidenced by restricted yeast reproduction, irregular "attenuation," and other troubles, is frequently in evidence in breweries, and the determining cause which leads to such "weakness" is often very obscure. No more difficult problem is presented to the brewer than that of yeast weakness, bound up, as it so often is, with factors influencing the life of the yeast-cell of which at present our knowledge is very incomplete. Under these conditions it appears desirable to direct attention to the trend of recent investigation with regard to the influence of minimal quantities of certain reagents on the growth of living organisms, for knowledge is accumulating in this direction which may perhaps assist in explaining some of the problems in connection with yeast weakness in the brewery which are at present very obscure.

When a vegetable organism is regarded from the point of view of its ultimate chemical composition, we find that it is constructed of some or all of thirteen elements:—C. H. O. N. P. S. K. Na. Ca. Mg. Fe. Cl. and Si. These elements exist in combination as a multitude of very various compounds, and the development and life of the organism is usually supposed to depend on the available supply of these, its component

elements. But apart from the elements just named, which ordinarily appear to be essential for the construction and life of the organism, many other elements have been found in plants. These elements usually exist in very small quantities, and often are themselves comparatively rare constituents of the earth's crust. For instance, fluorine, bromine, and iodine representing halogens, are found in plants. Fluorine in peas and barley, bromine and iodine in most marine algæ.

Arsenic, according to Bertrand's researches, is an element constantly present in both animal and vegetable organisms in minute traces. Silver is also said to be present in minute traces in marine algæ. Rubidium, cæsium, lithium, copper, manganese, zinc, boron, and a number of other elements have also been recognised in minute quantities.

The occurrence of many of these elements in plants has been known for a long time, and for the most part there has been a tendency to regard their presence as accidentally acquired by the organisms under special conditions of environment, and not as constituents essential for their existence. Recent investigations tend to show, however, that some at least of the elements present in minimal quantities may be essential to the existence of the organisms containing them.

The French school of vegetable physiologists, led by Bertrand, have, during recent years, pursued investigations bearing on this subject, and there is a growing tendency in this French school to regard the ordinary elementary constituents of living organisms as "éléments plastique" (modelling elements)—and some, at least, of the elements present in minimal quantities, as "éléments catalytique." The suggestion that the action of certain elements present in minimal quantity may be catalytic appears to originate from the recognised catalytic action of enzymes, and more especially from the catalytic action of the oxidising enzyme, laccase, the activity of which depends, according to Bertrand, on the presence of minimal amounts of manganese.

At the present time two questions of much interest and importance are being asked:—(1) Is the presence of certain of the elements found in minimal quantities in vegetable organisms, and not usually regarded as plant-foods, necessary for their existence? (2) If traces of these elements are necessary, in what manner do they act?

Some very suggestive investigations in connection with these questions have been recently published by Henri Agulhon.*

The presence of boron in minimal quantity in the ash of many plants was called attention to by Jay in 1895, but Agulhon has extended Jay's work very considerably. Agulhon concludes that all the higher plants contain boron, and in support of this view demonstrates that twenty-six different species examined, representing eighteen different orders of the phanerogams and higher cryptogams, all contained boron. He considers that the life of the higher plants may not be possible without the presence of small amounts of boron, but is unable to confirm this view owing to his inability to provide a medium of growth which is quite free from boron. He shows, however, that boracic acid in minimal doses has a remarkable effect in stimulating the growth of the higher plants. On the other hand, it appears to have no stimulating influence on low forms of plant life such as yeast and moulds.

However, my chief object just now is to call attention to some very striking work on the influence of zinc in minute quantities on plant life which has been carried out recently by Javillier, a French investigator and a pupil of Bertrand.

It has been known for a long time, from some remarkable work of Raulin, a pupil of Pasteur, that minimal quantities of zinc exercise a very favourable influence on the growth of certain moulds. In a thesis published in 1870 Raulin described the results of some investigations on the growth and development of the mould Aspergillus niger under varying conditions of food-supply which indicated that zinc, ordinarily regarded as poisonous to plant-life, was necessary for the proper nutrition of this organism. The amount required, however, appeared to be exceedingly small, and Raulin found that so little as one part of zinc in one hundred thousand of the nutritive solution in which the fungus was grown seemed to be sufficient for its needs. This old work of Raulin has been quoted frequently as instancing the marked influence which exceedingly minute quantities of reagents may exert on the growth and functions of living organisms, but in the absence of any confirmation of Raulin's work it has hitherto been accepted with some reserve. Javillier's work has now, however, amply confirmed Raulin's. Javillier, in the first instance, repeated Raulin's experiments with Aspergillus

* "Thesis," University of Paris, 1910.

niger, and found that one part of zinc in one hundred thousand of the standard nutritive solution employed by Raulin in his experiments led to an increase in weight of the fungus of nearly 300 per cent. But further experiments made by Javillier with still smaller amounts of zinc demonstrated that the minimal quantity necessary for the full development of Aspergillus niger was much smaller than the one found by Raulin. The following table shows the results of a series of experiments by Javillier, in which dilutions of zinc from 1 in 250,000 to 1 in 2,500,000 were employed.

The weights of fungus obtained with the different dilutions are given in the third column of Table I.

TABLE I.

Zinc in 250 c.c. of liquid.	Dilution 1 zinc.	Dry weight of Aspergillus.
0·0 mgm.	—	2·93 grms.
0·1 ,,	2,500,000	4·43 ,,
0·2 ,,	—	4·43 ,,
0·3 ,,	—	4·28 ,,
0·4 ,,	—	4·22 ,,
0·5 ,,	500,000	4·40 ,,
0·6 ,,	—	4·10 ,,
0·7 ,,	—	4·10 ,,
0·8 ,,	—	4·12 ,,
0·9 ,,	—	4·38 ,,
1·0 ,,	250,000	4·43 ,,

It will be noticed that the weight of fungus obtained in the complete absence of zinc, viz., 2·93 grms., rises at once to 4·43 grms. in the presence of zinc when in a dilution of 1 in 2,500,000, and that subsequently the weight of fungus remains constant in the presence of larger amounts of zinc, evidencing that a dilution of zinc of 1 in 2,500,000 is sufficient to supply all the needs of the organism.

But there is nothing in these experiments to show that even smaller amounts of zinc than 1 in 2,500,000 may not be sufficient to supply the needs of the fungus. Consequently Javillier conducted a second series of experiments with still more dilute solutions of zinc, the results of which are given in Table II.

From these experiments we see that a dilution of zinc of 1 in 25,000,000 exercises a marked influence on the development of the

TABLE II.

Zinc in 250 c.c. of liquid.	Dilution 1 zinc.	Dry weight of Aspergillus
0·00 mgm.	—	1·65 grms.
0·01 ,,	25,000,000	2·75 ,,
0·02 ,,	—	2·98 ,,
0·03 ,,	—	4·22 ,,
0·04 ,,	—	4·30 ,,
0·05 ,,	5,000,000	4·41 ,,
0·06 ,,	—	4·54 ,,
0·07 ,,	—	4·60 ,,
0·08 ,,	—	4·30 ,,
0·09 ,,	—	4·10 ,,
0·10 ,,	—	4·43 ,,

fungus, but that the amount required for its full development is about 1 in 8,000,000.

Still more dilute solutions were employed by Javillier in order to ascertain the smallest amount of zinc capable of exerting any influence on the development of the fungus. (See Table III.)

TABLE III.

Zinc in 250 c.c. in liquid.	Dilution 1 zinc.	Dry weight of Aspergillus.
0·000 mgm.	—	1·91 grms.
0·005 ,,	50,000,000	2·53 ,,
0·010 ,,	—	2·81 ,,
0·015 ,,	—	3·20 ,,
0·020 ,,	—	3·63 ,,
0·025 ,,	10,000,000	4·45 ,,

It will be seen from these experiments that the minimal quantity of zinc capable of exerting a noticeable effect on the growth of aspergillus niger is the almost inconceivably small amount of five one-thousandths of a milligram in 250 c.c. of the nutritive solution—or a dilution of 1 in 50,000,000.

How such an exceedingly small amount of substance can play a part in the economy of a living organism unless it functions in some manner as a catalytic agent, as the French school of vegetable physiologists suggests, appears very difficult to conceive. Evidence is undoubtedly accumulating which tends to

confirm the French view that in many cases minimal quantities of hitherto unsuspected agents may play a very important part in the phenomenon of life, and this view should not be lost sight of, as I have remarked before, when studying the often obscure phenomenon of yeast weakness in the brewery. It is true that Javillier's investigations demonstrate that zinc does not exert the same influence on the development of yeast as it does on Aspergillus niger, but, arguing from analogy, other as yet unrecognised chemical agents of an organic or mineral nature present in minimal quantity may play a very important part in the economy of the yeast-cell. In connection with this subject it is well to bear in mind evidence brought forward by Wildiers and others in connection with so-called "bios"—a substance the presence of which in minimal quantity is said to be necessary for yeast growth. The evidence in favour of the existence of "bios" is by no means generally accepted, but on the other hand it is not altogether disproved.

At the commencement of these lectures I said that scientific knowledge in connection with brewing had grown to such vast proportions that it was impossible to review it as a whole in many more than four lectures, and that all I could attempt in the brief time at my disposal was to select a few subjects associated with the different main processes of brewing and endeavour to treat them somewhat fully. I have tried to carry out this plan, but have felt, as my lectures proceeded, my inability to treat even the few subjects selected with any approach to thoroughness, and it must be only too apparent how much has been left unsaid with regard to the subjects I have attempted to discuss. The fact that the processes of the brewer have their origin in the complexities of life, renders discussion of any point in connection with them—however simple it may appear at first sight—many sided, and lengthy.

There is no simplicity in the processes of vitality, and the further we push our investigations into the realms of bio-chemistry, the more complex do the inner reactions of life appear. This constitutes the great difficulty of the brewer's art, but it also constitutes its great charm; it brings us into direct contact with many of the problems of life, and of necessity leads us to attempt the unravelling of some of them. It is very true that the brewer owes much to science for the progress his industry has made in recent years, but, on the other hand he can justly claim that, in return, the advance of modern science has received material assistance from investigations connected with brewing. I believe there is no other industry which can, in this respect, exhibit as good a record.

RECENT DEVELOPMENTS IN RADIO-TELEGRAPHY.*

The principal cause of the difficulties experienced to-day in maintaining satisfactory communication by means of radio-telegraphy is to be found in the phenomenal growth of this means of transmitting intelligence. The difficulties are mainly due to interference between different stations working simultaneously. Formerly the only disturbance was that due to atmospheric influences, but these are now becoming of less comparative importance, due to the great multiplication of radio-telegraphic equipments and the increasing power used in their sending apparatus. These difficulties promise to increase steadily in the future, and it is therefore a matter of some importance that we should consider the recent developments in the apparatus employed and in the principles involved.

Nearly all the developments, both in the sending and in the receiving apparatus, have had as their objective the decrease in the interference caused to, or suffered from, other stations. This is, at the present moment, of far greater importance than efficiency or even reliability.

Since the earliest experiments in radio-telegraphy, it has been sought to decrease the decrement of the train of waves which accompanies each spark. The sending apparatus in common use at the present day differs, however, but little in principle from that used with the earliest coupled aerials. The spark-gap is either stationary and provided with a powerful air-blast, or the electrodes are rotated at a high speed, thus causing movement of the air, and at the same time bringing cold metal surfaces to act as electrodes. The production of undamped or slightly damped trains of waves by means of Poulsen or Lepel arcs has not made the revolution in radio-telegraphy which was predicted, while the quenched spark between plane metal surfaces a fraction of a millimetre apart falls far short of the long open gap in reliability. The unquenched long gap necessitates very loose coupling, and therefore very low efficiency if beats in the emitted waves are to be avoided. If the coupling is made tighter than about 5 per cent., undue interference with other stations will probably ensue.

A great improvement has taken place in the nature of the note sent out by most large stations.

* Abstract of a paper read by Professor G. W. O. Howe before the Engineering Section of the British Association at Portsmouth, 1911.

In the earlier arrangements the sparks followed each other so irregularly, or the spark frequency was so low, that the signal heard in the telephone was nothing more than a crackling noise, very similar to, and easily confounded with, the noises due to atmospheric disturbances. It is not essential to tune out all other signals and extraneous noises, if the signals which have to be received have a distinctive musical note. This has led to the frequency being increased from ten or twenty to five hundred or a thousand sparks per second. The difficulty of getting, with any regularity, a thousand sparks per second with an ordinary gap and a power of several kilowatts will be apparent. If the use of a certain note became general, much of its advantage would be gone, but it would still be a great improvement in combating atmospherics.

Although the receiving arrangements have been made very convenient for rapid tuning, no radical change has been made in the detectors employed. One has still to choose between reliability and sensitiveness. If extreme sensitiveness is not desired, the magnetic detector is ideal in its simplicity. For the reception of weak signals we have the Fleming valve, the electrolytic and various crystal detectors, if necessary, in conjunction with the Brown telephone relay. Attempts have been made to obtain selective working by tuning the reed of the relay, but the general utility of the station so equipped would be greatly reduced, to say nothing of the adjustment and manipulation required.

ARCHÆOLOGY IN PERU.*

In recent years there has been much activity in the field of Peruvian archæology. At Tiahuanaco (which must always be associated with Peru, though now within the borders of Bolivia), M. G. Courtz, of the expedition of MM. Sénéchel Lagrange and de Créqui-Montfort in 1903, excavated the wide monolithic stairway which forms the eastern entrance to the great enclosure called Kalasasaya. He then dug along the western line of monoliths, and found that they were connected by a wall of cut stone. On that side he uncovered the double walls of another enclosure, and to the east he found a smaller one, constructed in similar style to the Kalasasaya, with upright monoliths at almost equal distances from each other, and a connecting wall of smaller squared stones, uncemented. From this wall projected a number of human heads, carved in the round from trachyte, and apparently portraits. Some of them are now in the Museum at La Paz. In 1910 the Bolivian Government had the Puerta del Sol set upright and cemented, and erected a shelter for the many sculptured stones which had been found. An underground chamber of carefully cut and fitted stone, discovered in 1908, is only 1 m. 40 cm. by 1 m. 30 cm. (not including five steps which lead down to it), and 1 m. 83 cm. high. The roof is of flat slabs of andesitic lava. Five colossal statues have been disinterred, of which the larger is 5 m. 72 cm. high. They are covered with finely incised designs. On the breast of one is a figure of the deity represented in the centre of the Puerta del Sol, surrounded in this case by standing personages. Another has several minute faces on its hands, and a face on each finger-nail.

Small portions of the great pyramid-building Ak-kapana can be seen—terrace walls of well-cut stone, but the masses of earth thrown out from the excavation of the centre (the present hollow is said to be more than 300 feet in diameter and 60 feet deep) hide the greater part. At Pumapanku, on the opposite side of the Indian town, a number of huge blocks of stone remain at the edge of the plateau. Although many hundreds of tons of worked stones have been removed from the ruins for different purposes, there is no doubt that systematic excavation, conducted by competent persons, would result in discoveries of the greatest interest. It is a mistake to suppose that because Tiahuanaco is at the altitude of 12,000 feet, the climate is too frigid for comfort. In the middle of winter there the early mornings are cold, and frost may lie in the shade all day, but the sun is hot and the air invigorating. Plentiful crops of barley are gathered, besides the native quinces and potatoes, and the Indians are well nourished and clothed, capable of long journeys with their lamas and other animals. On St. Peter's Day they assemble in thousands to perform their ancient dances in the town square, as described by Squier. A curious feature is that those who wear great feather crowns resembling the tops of palms, after dancing for some hours, place them in the centre of the ring and continue to dance round, bending towards the crowns as if in worship.

The amazing richness of Peru in antiquities is seen in the galleries of the National Museum at Lima, which Dr. Max Uhle has filled with the results of two years' excavation in the region of Nazca, the neighbourhood of Lima, and near Trujillo, all coast civilisations. In the bay of Ancon, the first settlements of primitive fishermen were on the side hills which slope to the sea, where the rocks are covered with shellfish. Then followed the wide-spreading town which filled the sandy area between sea and mountains, known from Reiss and Stübel's book as the Necropolis of Ancon, but now proved to have been a series of skull heaps and of reed huts, which decayed or were destroyed after the owners had been buried under them with their possessions, when others were built above. The accumulated material covers a space more than a mile square and 30 feet high. The graves are small pits lined with pebbles. Dr. Uhle spent several years in excavating at Pachacamac for the University of Pennsylvania, and has been able to form some idea of the sequence of the different kinds of

* Abstract of a paper read by Miss A. C. Breton before the Anthropological Section of the British Association at Portsmouth, 1911.

pottery from his finds there and in other places. The beautiful painted pottery at Jea and Nazca proves to be earlier on the coast than any other, and the primitive fishermen learned the art of vase-painting from the proto-Nazca folk. Richly clothed mummies, feather garments of symbolic design, mosaic ear-plugs, gold and silver cups, and a cuirass covered with small metal plates, are some of the treasures of the Lima Museum.

Of the remoter Stone Age little is yet known in Peru, but chips and scrapers are found in the alluvium on the plain of Lima, and the deposit with fragments of rude pottery, observed by Darwin, can still be seen on the top of the cliff near Bellavista.

THE NEW INDIAN FRONTIER EXPEDITION.

The punitive expedition against the Abors promises to be of a more serious character than was at first apprehended, mainly because it is directed against a semi-savage people, who have the very vaguest notion of the material power of the British rule, and who have never yet been impressed or overawed by a display of our arms of precision, such as has been forcibly brought home to the tribes on the North-West Frontier any time during the past sixty years. Moreover, the Abors are said to be able to put into the field a fighting force of from 20,000 to 30,000, armed with spears, long swords, and bows and arrows, while all the chief villages are defended by strong stockades, so that it is obvious that the somewhat elaborate preparations made by the Government of India for operations in the dense jungle-covered country inhabited by these truculent tribesmen were fully justified. The murder of Mr. N. Williamson, Dr. Gregorson, and the forty Nepalese coolies accompanying them, happened last April, and though a small force of military police was promptly got together to rescue any of the survivors, no effective advance could then be made owing to the rainy season. The present force will consist of about 2,500 men of the 8th Gurkhas, 32nd Pioneers, and a company of Sappers, with a battalion of the 2nd Gurkhas as reserve, and 500 military police with seven-pounder guns. Major-General Bower, C.B., will be in command.

The scene of the present operations lies in the hilly country intermediate between eastern Tibet and the north-eastern angle of Assam, the furthest province of British India. As far back as the seventies the Abors molested and insulted one of our political officers, and it is difficult to understand why they were not brought to book on that occasion. Our inaction was construed as weakness, and the Abors proceeded to come down to our frontier and levy toll on the Miris, and threatened to burn the sawmills at Lamirkeri. Their next step was to dispute our ownership to the country between the Brahmaputra River and the foot of the hills. Complaints arose from British subjects in these parts, engaged in elephant catching, on whom the Abors levied blackmail. With the appointment of Mr. Williamson as Political Officer in 1900, a rather more satisfactory state of things was established. He made frequent excursions into the Abor country, and amassed considerable information respecting the people, their villages, and their resources. His life was threatened more than once, but he always replied, "If you kill me my King will send, not ten men, nor a hundred men, to avenge my death, but thousands will be sent and you and your cattle and crops will be destroyed." The Abors, who had never seen more than 300 of our soldiers, were, however, incredulous and contemptuous, and it was in one of these expeditions that Mr. Williamson, Dr. Gregorson, and his party were massacred a few months ago.

A geographical problem of great interest awaits solution in connection with this expedition, this being the actual identification of the Dihang River, which joins the Brahmaputra in Upper Assam as the lower course of the great Sanpo or river of Tibet. This fact was disputed many years ago by the famous geographer, Klaproth, who contended with much elaboration that the Sanpo flowed out further east into the upper Irrawaddy. The gradual development of geographical knowledge from the Indian side has made it practically certain that the river known in Assam as the Dihang can be none other than the Tibetan Sanpo. The last explorer was an agent of the Indian Survey Department named Kinthup, who was commissioned by Captain Harman in 1880 to descend the Sanpo from the Tibetan side and cast a number of specially marked wooden logs into the stream, watchers being posted at the mouth of the Dihang in British territory to note if these logs were duly floated down. The endeavour proved unsuccessful, but Kinthup collected some useful topographical information, and claimed to have followed the Sanpo in its southern bend or elbow to a point thirty-five miles from the British frontier. If correct, this would seem fairly conclusive on the point of identity. At the time of the Younghusband expedition to Tibet, some pressure was brought to bear on the Indian Government to permit a small exploring column to return from Lhasa to India by way of the Sanpo River, but fear of the Abors induced the Viceroy to withhold the necessary sanction for that expedition. Without the co-operation of another column from the Assam side such an undertaking might clearly have been risky. On the present occasion, however, exploration and reconnaissance are a military necessity, and we may fairly conclude that the unknown section of the river will be surveyed from the Tibetan to the British frontier. This will include the celebrated falls of the Sanpo, which may be said to mark the spot where the river bursts through the chain of the Himalayas in its descent from the plateau of Tibet to the plains of India.

HOME INDUSTRIES.

The Cardiff Strike.—How easy it is for workmen to injure themselves, even when their demands have been granted, is shown by the seamen's strike at Cardiff. The number of unemployed sailors in the port of Cardiff at the present time is extraordinarily large, and it is so as a direct result of the strike in which they were the apparent victors. For the exceptional number of the unemployed is due to the action of the seamen's leaders in demanding under the recent Agreement a *minimum* wage of £5 per month, whereas the prevailing wage in most other ports is £4 10*s*. To avoid being penalized 10*s*. per month per man the Cardiff shipowners are signing on their crews elsewhere. On the other hand, many seamen have flocked to Cardiff from other ports in the belief that by so doing they would be able to secure higher wages. It is now said that the leaders of the men are inclined to accept the view that the wage secured by the Agreement is too high, but unfortunately it provides that there shall be no alteration in the port wage rate until three months' notice has been given by either side.

The 1889 Strike.—It has been generally believed that the London Dock strike of 1889, in which the present President of the Local Government Board figured so prominently, resulted in a great victory for the men, but it may well be doubted if, on the whole, they were any gainers by it. A correspondent of *Fairplay*, who for years held a prominent position in the labour department of the Millwall Dock Company, submits some facts which suggest that the men lost rather than gained by the strike. Prior to it, in 1889, the dock men were paid at the rate of 5*d*. per hour, and the recognised day was 8 a.m. to 6 p.m., with nothing deducted for meals; so that the men received pay for the full ten hours, making their day's money 4*s*. 2*d*. They struck work in August 1889, for 6*d*. per hour. After being out of work for a month, they got it, but on the condition that they would not be paid for the dinner-hour as heretofore. Thus their money, if they worked up to six o'clock, would be 4*s*. 6*d*. instead of 4*s*. 2*d*. After the strike the masters made the day eight to five instead of eight to six, the hour between five and six being an unprofitable one, as very little practical work was performed. As under the new agreement the dinner-hour was deducted, the men only received pay for eight hours at 6*d*., being 4*s*., against 4*s*. 2*d*. previously. Nor was this the only way in which they suffered. The labour employed was reduced to a minimum, and the men chosen were more severely looked after, with a view to getting the best work out of them, and as a consequence of the strike an immense amount of work was lost to the Port of London, and went away to Antwerp and other foreign ports, which has never been recovered. The men were the sufferers on all points, and the strike saddled them with the cost of maintaining an expensive union. It left the men worse off than it found them, and it has yet to be shown that the recent revolt will be of any greater permanent value to them.

The Whisky Trade.—When the duty on whisky was raised to 14*s*. 9*d*. per proof gallon it was believed that it would seriously check consumption, and for a few months it did so, but the effect seems to be passing away. Up to the time of the increase in the duty the consumption of Scotch whisky was progressive, and in the first six months of its operation the reported turnover declined about one-third, but the visible consumption now begins to show signs of improvement, and the returns have gradually improved. In 1905, stocks amounted to no less than 121,778,000 gallons, or about five years' consumption at normal rate, but since then they have declined somewhat, and one effect of the reduction has been to reduce the accumulations of old matured malt whisky, whilst the reduced make of recent years has sensibly lessened the quantities of young grain whiskies required for blending purposes. But now an increased demand has arisen for these whiskies, to make up for the growing deficiency in the stocks to meet the requirements of blending, which have been hurried into the market to secure young whisky for trade purposes before speculators drive up the prices too high for profitable trade. The result is that the younger makes of whisky in bond have risen much above the prices current a year ago, while old grain whisky is half as dear again. The rise in the price of maize, too—the chief raw material of the grain distiller—has been considerable, and is likely to continue. If it does there must be further rise in the price of new grain whisky, and the continued activity of the distillers, both grain and malt, may safely be predicted.

The Harvest.—One feature of the 1911 harvest is its earliness, and the quickness of its gathering in. Begun in Wiltshire on July 18th, it was over nearly everywhere in England by September 2nd, and in the Home Counties by August 19th. It would be strange if, with the weather we have had, the wheat crop was other than first-rate, for there was a favourable preparation for the germinating time, an adequate rainfall to sustain growth between the beginning of March and the end of June, and since then a period of almost unbroken heat and sunshine, with high temperature by night as well as by day. Accordingly the quality of the wheat is as good as that of the 1910 crop was bad. It is nearly all up to the miller's standard, is fit for immediate milling, and needs very little admixture of foreign corn, and the yield will be above the average, although there is considerable variation in different districts. The new barley crop is estimated at 86·67 per cent. of a full crop, which is the lowest estimate since 1903, and five points below the average of the previous ten years. Taken as a whole, oats are the worst of the cereal crops, but in some districts they are exceptionally good,

as in Norfolk. Taking the average of the cereal crops, the *Times* puts it at 83·7, the lowest average for the last fourteen years, with the exception of 1905, when it stood at 83. The hay crop was of exceptionally good quality but short in quantity, and in many counties there has already been resort to hay-ricks. Roots, it need hardly be said, are in sad plight, even mangel-wurzel being very small. As to swedes and turnips, in many places they have practically disappeared. Hops are good in Kent, and in some districts of better quality than for many years. Hereford reports a small crop of good quality. The Gloucestershire hop cultivation has almost disappeared, and the total acreage under it continues throughout England—the only part of the Kingdom where hops are grown—to diminish rapidly.

Retail Prices.—There is general complaint at the rise in food prices, but it is not very easy to see how these rises, or most of them, can be justified, for they are not to be reconciled with market quotations. Flour should be the best guide to the price of bread, but figures given by the *Mark Lane Express* show that the price of September 1910 has never since been reached, while in each quality there has been a decline as compared with a year ago. Yet the average price of bread has risen. Take again meat. The same authority gives tables of the prices of cattle and sheep at the Metropolitan Market, Islington, which show that, so far from there being a rise in the price of cattle, there has been a decline in three classes as compared with a year ago, and no change in the other two. And it is almost precisely the same with sheep. Yet meat is dearer. And so with poultry and eggs. The price of poultry, balancing one variety with another, is much the same as a year ago, and eggs are cheaper. Bacon is another commodity that costs the consumer more than it did a year ago, but the market price of Irish bacon, the only kind quoted, has fallen in price.

The Flax-mill Dispute.—Reference was made in these Notes last week to the flax-mill dispute at the Broughton flax-mill, where the women and girls struck for better wages. The dispute has now been settled and the strikers have returned to work, the employers having made substantial concessions. The settlement is a compromise. The workers have not got all they asked for, but they have got a good deal. Men, women, and girls alike are substantially bettered. The bonus system has not been got rid of, but whereas before the strike, if only one day were lost in the week there was no bonus that week, and in the case of the reelers, if only a quarter day were lost the bonus went, the new conditions are more favourable. And the concession of a minimum wage of 20*s*. a week to the labourers is a substantial gain. The pity is that these readjustments of wages are not brought about without strikes.

Cotton Supplies.—It would seem that the expectation of a bumper American cotton crop—a crop of 14,000,000 bales—must be abandoned. At the end of July the average condition was given as 89·1, the highest for the time of year since 1894, but the United States Agricultural Department's report for August shows a drop of 15·9 to 73·2, the greatest August depreciation since 1902, when it was 17·9. For some years the condition figure at the end of August has been a fair index of the size of the coming crop, but much depends upon September. It was hoped that the crop this year would be the highest on record. That is no longer likely, but with a good September it may exceed that of last year, namely 12,120,000 bales, and may reach 13,000,000, seeing that there is this season an increase of acreage which will probably bring something like an additional half million bales. It is a little curious, by the way, that the weather and crop reports during August did not indicate the great deterioration recorded by the Agricultural Department.

CORRESPONDENCE.

THE PEA-NUT.

The valuable paper in the *Journal* of this date, on the "Pea-nut" industry of Marseilles, is defective for its many Anglo-Indian readers in not stating that the "Pea-nut" is their "Earth-nut," "Ground-nut," and "Manilla" gram ["gram" = *Cicer arietinum*, the "Chick-pea"], the *Arachis hypogæa* of Linneus, known to the natives of India by the names of *mung-phali* ["*Phaseolus Mungo*-fruit"], *bhui-chana* ["Earth-gram"], *chini-badam* ["Chinese-almond"], and *vilati-mung* ["Foreign-*mung*"], etc., etc.; this leguminous plant, although now cultivated over all India and the East Indies, from Abyssinia to China, being a native of South America; and one of the numerous economic plants of that continent introduced, through the intermediation of the formerly puisant Portuguese into Africa and Asia; one of the greatest services rendered by any nation to humanity at large, but for which they never get any credit in the standard histories of Portugal.

For tastefulness the "Earth-nut," or "Pea-nut," may be classed with the "Cashew-nut," and the "Pistachio-nut," the *Pistache de terre* of the French; but all three are most indigestible. The oil, in salads, is a good enough substitute for olive oil; but both olive oil and "Pea-nut" oil are inferior in delicacy of smell and taste to almond oil; while almond oil itself must yield the palm for purity of savour to Sesamum oil, the product of *Sesamum orientale*, or *indicum*, of Linneus—the *tila*, that is "the oil," *par excellence*, of India; which from the first dawnings of human history in the valleys of the Tigris and Euphrates, and the Nile [Semitic *sim-sim*, Hebrew *semen* = "oil" generally, Arabic *al-jul-jul-an*, our "Gingelly," Greek *σήσαμον*, etc.], has been used throughout the East for food, both in the grain and

the oil pressed from it, and the oil also for lighting purposes: this latter use of it having given rise to the phrase:—"Open Sesame!"—meaning, simply, as we should say, "Strike a light," "Bring a candle," "Open up the darkness." "Open Wheat!" "Open Rye!" "Open Barley!" were of no avail, and only when Kasim cried "Open Sesame!" was the treasure in "Ali Baba and the Forty Thieves" revealed. I was the first to point this out in the first edition of my official "Catalogue of the Economic Botanical Products" of the Government Central Museum, afterwards [1857-8] enlarged into the Victoria and Albert Museum, Bombay. Cotton and Sesamum are the two most reliable crops in all India; and the proverb runs throughout Southern India:—"When a failure [of the harvest] is feared, at once sow Sesamum."

Along the Concans coast of western India the household illuminant used by the fisher-folk is a fish through which a wick is drawn, and, as required, lighted; and it is remarkable that the brazen lamps used in the temples of the Concans, and up, over the *ghats*, in the valleys on their Deccan slopes, is formed on the longitudinal section of a fish, head and tail and all, with a cup-like hollow, below its belly, to serve as a pedestal, and hold the oil, the wick being drawn out into its head.

September 8th, 1911. GEORGE BIRDWOOD.

GENERAL NOTES.

MILITARY AVIATION IN ITALY.—The new aerodrome at Aviano, which will be the largest in Europe, covers an area of upwards of 12,000,000 square metres (nearly 3,000 English acres) in the communes of Aviano, Rovereto in Piano, San Quirino and Pordenone, near Udine. The twelve hangars will contain sixteen aeroplanes of the Farman and the Blériot types, most of which have been built by the mechanics of the specialist brigade of aviation. Two aeroplanes of the Etrich type, recently purchased at Vienna, and a Newport machine made in France, are also ready for use. Workshops and accommodation for the men of the brigade are also provided. The aerodromes at Bovolenta and at Gallarate are now ready. The workshops for the construction of aeroplanes at Centocelle (Rome) have now been transferred to Gallarate. The three establishments are under the command of Colonel Montezemolo, the director of military aviation.

THE FISH INDUSTRY OF THE PHILIPPINES.—The latest fishery enterprise in the Far East has been the canning of sardines and anchovies in the Philippines. At the recent fair held in Manila were displayed fifty cases of sardines put up by the Bureau of Science of the Philippine Government. The fish were packed in peanut-oil of Philippine production, with the usual spices, in oval tins furnished for the experiment by local Chinese tinners. The fish were first salted and cleaned, soaked in brine, and washed to remove the scales, dried in the open air, boiled in oil, drained off and packed. The tins, after being soldered, were immersed in boiling water for two hours. This simple process produced a fair grade of packed fish. The peanut-oil can be had in large quantities at comparatively low prices. The supply of sardines and anchovies in Philippine waters is said to be very large. Sufficient of these fish are said to be caught in Manila Bay alone to supply a factory catering not only for the needs of the Philippine Islands in the way of packed fish of this grade, but for a considerable export trade as well. The Philippine species of sardines and anchovies are reported to be delicate little fish of exceptionally good flavour and fair size, and compare favourably in all respects with similar fish in all parts of the world.

THE SPANISH WINE INDUSTRY.—The world's output of wine amounts to about 3,700 million gallons, of which one-seventh, or 500 million gallons, was produced by Spain in 1909. To this should be added about thirteen million pounds of dry grapes exported to France and Italy, representing 20,000 tons of fresh grapes, which, at the low rate of one hundred gallons of wine to the ton, would represent two million gallons of wine. Spanish wines are divided into red, yellow and white, and each of these again into dry and sweet. They are all native wines, produced by natural fermentation, without any adulteration. Only a little blending is done for the sake of their colour, aroma and flavour. Dry wines do not contain more than 2 to 5 per cent. of alcohol; sweet wines 10 to 12 per cent., and seldom more than twenty per cent. In the fermentation of the wines no sugar is added. The vines are grown on clay soil, which contains both iron and lime. An acre of land frequently yields as much as five hundred gallons. The wine most exported from Spain is the ordinary red wine in pipes or casks.

THE SILKWORM INDUSTRY IN KOREA. — The Japanese have recently been advertising in the district of Antung for fifteen hundred Chinese cocoon experts to promote silkworm breeding in Korea. It is thought that the silkworms of Manchuria will thrive in the northern part of Korea, as the climate in the two countries is similar. The Japanese have therefore bought about one million cocoons from the Chinese at fancy prices, and commenced their experimental work in June, 1911. The Manchurian silkworm is a valuable variety, and produces a thread which is very thick and strong. This is largely due to the severity of the winters, which causes the silkworms to spin a cocoon heavy enough to withstand the cold. Unlike most other silkworms also, the Manchurian variety feeds upon the oak trees which are abundant in the district of Antung. As the same kind of oak is found in the northern portion of Korea, the new industry is, it is said, likely to become one of the most important in that part of Japan's recently-acquired territory.

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THE ROYAL SOCIETY OF ARTS.*

By Sir Henry Trueman Wood, M.A.,
Secretary of the Society.

III.—The Society's Offices.

The first permanent offices of the Society were in Craig's Court, Charing Cross. At a meeting held on February 19th, 1755, at Peele's Coffee House, arrangements were finally made with Shipley that he should take a house in Craig's Court, and sublet a portion to the Society. Whether the rest of the house was used by Shipley for his Academy or not, there is nothing in the Minutes to indicate. The rent paid was £20 a year, including coals and candles. The first meeting at Craig's Court was held on March 1st, 1755. Here the Society remained for a year, but the rooms were too small, so they moved to a house at the corner of Castle Court on the east side, "opposite the New Exchange," on June 2nd, 1756. For this they paid to John Fielding a rent of thirty-five guineas for the first floor and some other part of the house. Castle Court was a narrow alley leading from the Strand to Chandos Street. It disappeared when the district was rebuilt in the reign of William IV., the date being commemorated by the names of King William Street and Adelaide Street. The ground on which the house containing the Society's offices stood now forms part of the site of the *British Medical Journal* office.

The accommodation, however, soon proved insufficient for the growing needs of the Society. It was increasing rapidly in numbers and in wealth, and it soon seems to have felt the need of more spacious quarters. Two years after it was established in Castle Court, we find in the Minutes that inquiries were being made for new premises. Several localities were suggested and rejected. In May, 1758, a committee reported favourably on a proposal to acquire Exeter Change. It appeared that a total outlay of £2,500 would have been required for necessary repairs and alterations, and that Lord Exeter was willing to grant a lease for about sixty years at a rent of £200 a year. As a set-off against this, there was the rent of certain shops forming part of the building, and to be sub-let by the Society. The outlay, however, was considered too great, and the proposal was declined.

Eventually the Society came to terms with Messrs. Williams and Woodin, who carried on the business of upholsterers and carpenters in premises opposite Beaufort Buildings in the Strand. These premises included the house afterwards No. 380 and 381, Strand, and a warehouse and yard behind. Messrs. Williams and Woodin agreed to build a Great Room for the Society on the site of their warehouse, and to let this room, with another good-sized room on the ground floor, together with a certain part of the house, for a payment of £200 and a rent of £120 a year for three years, and £100 afterwards, for a term of fifteen years from Midsummer 1759. The first meeting in the new rooms was held on July 18th in that year. The various alterations in, and additions to, the buildings were made under the superintendence of Mr. (afterwards Sir William) Chambers, who acted as the Society's architect. He later achieved a great reputation, his best-known work being Somerset House.

It has not been found possible to make out precisely how much of the Strand frontage was occupied by the Society. They certainly had an entrance on the Strand, and perhaps they had the whole or part of the first floor. Or the original house may have been divided into two, and this idea is suggested by a comparison of the entries in the sewer rate-book for 1763 and subsequent years. The earliest entry shows one house, in the occupation of Thos. Wooden [*sic*]; the entry for 1765 shows the same house as

* The previous articles of the series appeared in the *Journals* of June 9th and 16th.

occupied by Geo. Box (in whose name the lease to the Society had been taken out) and formerly by Price, while subsequent entries show two houses. It was certainly for long in the joint occupation of the Society and the landlords, for both Williams and Woodin, who were members, have their addresses recorded in the lists as "Society's Offices."

The house stood on ground which was then part of the property of the Duke of Bedford, and had been leased by him in 1753 to John Price, by whom it was demised to Williams and Woodin. It was, when let to Price, the "Greyhound Tavern," but presumably Price or his successors gave up the tavern and used the premises for other purposes. The district extending a certain way eastwards from Southampton Street is designated in the rent-books of the Bedford estate "Fryers' Pyes," but up to the present it has not been found possible to ascertain the meaning of this curious title or to find any explanation of it.

For the information which has enabled the site of the Society's old offices to be identified, the writer is entirely indebted to Sir Laurence Gomme, the accomplished Clerk of the London County Council, and to Mr. A. R. O. Stutfield, the steward of the Bedford estate. Both these gentlemen have taken a great deal of trouble in hunting up obscure details in the records under their respective charges, and the writer has much pleasure in acknowledging the valuable and ready help they have given. It has always been known that the Society occupied offices "opposite Beaufort Buildings" from 1759 to 1774, but it had been assumed that these offices were at the north-east corner of Beaufort Buildings, in the house afterwards No. 96, Strand, long well known as Rimmel's, the perfumer's.

This, however, is undoubtedly a misapprehension, and it may be taken as quite certain that the building occupied by the Society was either on the ground now covered by the western wing of Haxell's Hotel, or partly on that ground, and partly on what is now Exeter Street. Exeter Street was originally a *cul-de-sac*, extending west from Catherine Street. The L-shaped extension, leading southwards into the Strand, was not added until much later. In all probability this limb of Exeter Street passes over and occupies the western side of the Great Room built by Williams and Woodin for the Society on the eastern side of the narrow alley then known as Little Denmark Court. The west side of this court is apparently coincident with the west side of the present Exeter Street.

All this district was altered under the Act (7 Geo. IV. cap. 77) passed in 1826 for the widening of the Strand, and in the various improvements carried out Exeter Change itself disappeared. Beaufort Buildings remained until 1902, when the extension of the Savoy Hotel swallowed it up, and all the old buildings on this part of the south side of the Strand disappeared. The courtyard of the hotel now occupies the ground which was formerly the roadway of Beaufort Buildings.

If the conclusions drawn from an examination of the plans and documents in the Bedford estate offices are correct, the "Great Room" was worthy of its name, being an apartment 80 ft. long by 40 ft. broad. It was here that the first exhibition of pictures by British artists was held in 1760. There was also a smaller room, 40 ft. by 20 ft., on the ground level, in which the first exhibition of models and machines was held in 1761.

A considerable amount was expended in fitting and furnishing the rooms and offices, besides the cost of structural alterations. Among other improvements it was found necessary to make a "crossing" in the Strand, at a cost of three and a half guineas, to facilitate the access to the Society's entrance door.

A year and a half later, in January 1761, some additional premises were taken by the Society from Woodin (Williams died in 1760, and his interest was acquired by Woodin), to be used as a residence by Dr. Templeman, the newly-appointed secretary. The description in the lease is not sufficient for them to be identified with certainty. They may have comprised a house adjacent to the Great Room and looking into Bennet's Court.

In 1770, the lease of the Society's premises having nearly expired, and the accommodation being again found insufficient, it was decided to advertise for new premises, and accordingly an announcement was inserted in some of the daily papers inviting any person who had proposals to make for the accommodation of the Society to communicate with the secretary.

The result of this advertisement was that the Brothers Adam, who were then occupied with their scheme for the construction of the Adelphi, offered to include in that scheme a suitable house for the Society's purposes.

The history of the Adelphi has often been

written.* The site was long occupied by the historic buildings of Durham House, the residence of the Prince-Bishops of the northern See. The house and grounds originally occupied the area between Adam Street and Buckingham Street, from the Strand to the river. The New Exchange was built in 1608 by Lord Salisbury on the site of the Durham House stables, and extended from George Court to what used to be Durham Yard, but is now Durham House Street. It thus included the site of Coutts's old Bank. It was pulled down in 1737, when shops and houses were erected along the present line of the Strand. In the space between these buildings and the river, where old Durham House once stood, fronting the river, with its gardens reaching to the Strand, were "a number of small low-lying houses, coal-sheds and lay-stalls, washed by the muddy waters of the Thames." The ground sloped down from the Strand level to the brink of the river, which must have been, at high water, somewhere about the inner edge of the Embankment Gardens.

Adelphi Buildings.

On this slope the Brothers Adam (Robert, William, James and John) proposed to build a great terrace, level with the Strand, the idea being taken from the arched terrace or gallery in the Palace of Diocletian at Spalatro,* which Robert Adam studied with great care, and described in a monumental folio.† The ground was in the possession of the spendthrift Duke of St. Albans, or rather of his trustees. By the year 1642 the estate had finally passed out of the possession of the Bishops of Durham, and under the provisions of an Act of Parliament it became the property of the Earl of Pembroke and Montgomery, a rent-charge only of £200 a year being reserved to the See of Durham. This rent-charge, it may be interesting to mention, is still paid by the present owner to the Ecclesiastical Commissioners. In 1677 the estate was sold by the Earl of Pembroke to Sir Thomas Monpesson, and in 1716 it was again sold by the representatives of Sir Thomas Monpesson to the trustees of the will of Sir John Werden, whose daughter Lucy married Charles, the second Duke of St. Albans. Their son George, the third Duke, brought the estate into settlement, and in 1767 a private Act of Parliament was passed for vesting part of his

* The fullest history of the Adelphi is contained in three articles by Mr. H. B. Wheatley in the *Antiquary* magazine for June, July, and September, 1884. In these a great deal of information will be found which it has not been thought needful to include here, as it has no special connection with the Society of Arts. Mr. Austin Brereton's "Literary History of the Adelphi" (1907) is the most recent book on the subject. Mr. Percy Fitzgerald devotes the best part of a chapter of his "Picturesque London" (1890) to the Adelphi.

* Fitzgerald, "Picturesque London" (1890), p. 39.

† "Ruins of the Palace of the Emperor Diocletian at Spalatro in Dalmatia," by R. Adam, F.R.S., F.S.A., 1764.

estates in trustees for the purpose of raising money to pay his debts.

These trustees, Lord Charles Spencer and Sir Philip Musgrove, in 1768 granted a lease to the Brothers Adam for ninety-nine years at a rent of £1,200 a year. It has seemed worth while to record these details because they have never been accurately stated in previous accounts of the Adelphi, and it is only by the obliging assistance of Mr. George Drummond, the owner of the Adelphi, and of Messrs. Fladgate, the solicitors to the estate, that it has been possible to trace out the manner in which this historic bit of London passed into the possession of its present owner.

The design proposed by the Brothers Adam was duly carried into effect, the requisite height on the river side being obtained by the construction of tiers of superimposed arches.* Some of these arches formed public thoroughfares, and later gained an unenviable reputation on account of their nocturnal frequenters. Others were let as storehouses; at one time a number of cows were stabled in some of the arches, and supplied milk to a large part of the West End. Others again served as cellars for the houses built on the substructure. The Society's house has two stories of cellars below the south-western part of the building, while the foundations of the north-east corner are in the original ground.† The whole work has undergone a certain amount of repair, a good deal of strengthening and reconstruction having been carried out about the time of the termination of the original lease, when the Thames Embankment was made;‡ but it seems now as sound as when it was first built.

The work, commenced in July 1768, was practically completed in about six years, but before it was finished the Adams were in financial difficulties. In the course of their operations they encroached on the foreshore of the Thames, and thereby involved themselves in a dispute with the Corporation, their difficulties being increased by the political circumstances of the time, as the Corporation were strongly Wilkesite, while the Adams enjoyed Court favour. Eventually they succeeded in obtaining an Act of Parliament to authorise their proceedings. In this they were assisted by their patron, the Earl of Bute. Their pecuniary difficulties were set right by means of a second Act, which empowered them to organise a lottery, the chief prizes in which were the houses then in course of building on the estate. In many cases the prize-winners sold their rights, and thus the sub-leases became the property of various owners. Their tenures expired at the termination of the principal lease in 1867, long before which time (in 1787) the property had come into the possession of the Drummond family. George, the third Duke of St. Albans, had no son, and was succeeded as fourth Duke by George Beauclerk, the grandson of Lord William Beauclerk, the second son of the first Duke, who had married (in 1744) Charlotte, the other daughter of Sir John Werden above mentioned. Lord William Beauclerk's daughter Charlotte married John Drummond, the son and successor of the Hon. Andrew Drummond, the founder of Drummond's Bank, and to her the Adelphi estate was devised by her nephew, the fourth Duke. From her son George the estate passed to his son, his grandson, and his great-grandson, George James Drummond, the present owner of the estate and the Society's landlord.

John Drummond and his cousin Robert were among the earliest members of the Society, and the connection of the family with the Society has since continued.

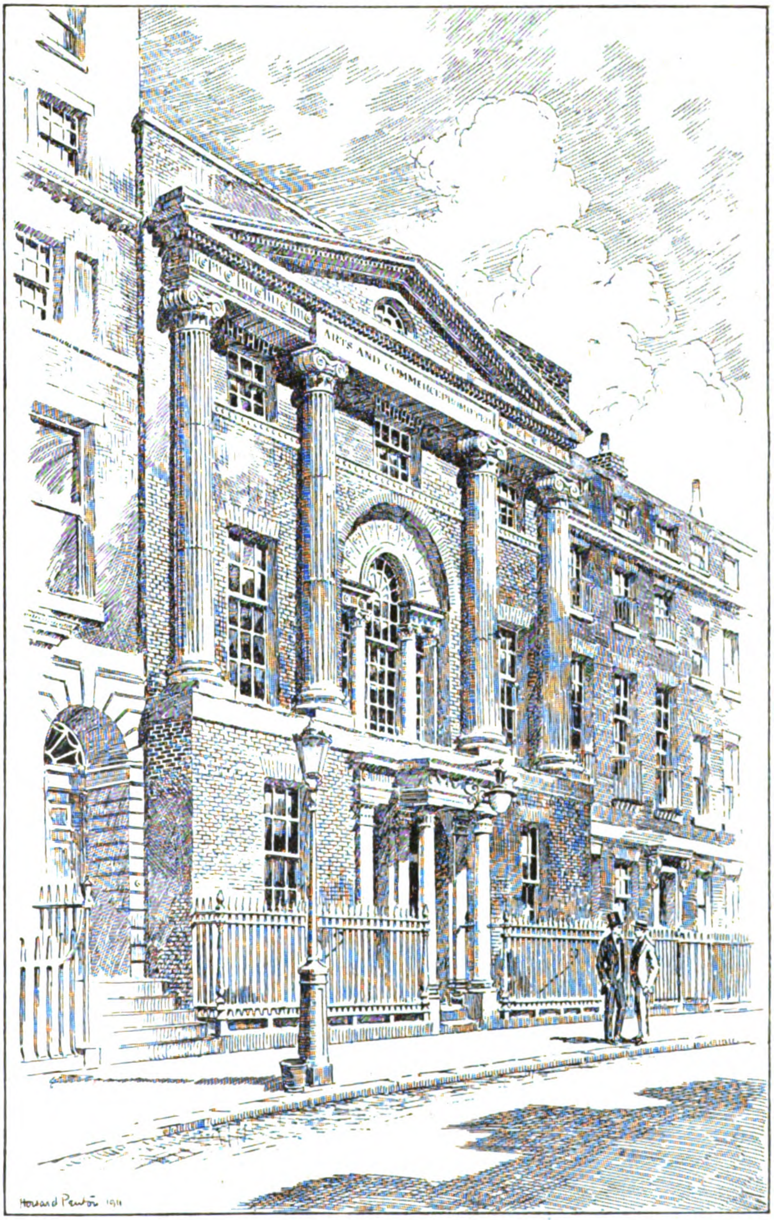
Negotiations, the progress of which is described, though not very fully, in the old Minute-books of the Society, went on for some time, and eventually the Adams undertook to build a house such as was required for a premium of £1,170, and a rent which was finally settled at £200 a year. The plans, after much discussion, were finally approved, the foundation-stone was laid by Lord Romney in 1772, and the Society entered into possession in 1774, though the lease only dates from 1775. It was for 91½ years, from Midsummer 1775, ending at Christmas 1866—a quarter before the end of the landlords' lease.

Such was the origin of the historic building in which the Society has carried on its work for 135 years. It really consists of two houses, one of which was intended for the private residence of the secretary. There has always been a communication between the houses on the ground and first floor (as well as in the basement),

* The view of the Adelphi (p. 1011) shows the Terrace with the houses as originally built, and justifies Horace Walpole's criticism (quoted by Mr. Wheatley) that the Adelphi buildings resembled "warehouses laced down the seams, like a soldier's trull in a regimental old coat." There are still two or three houses in the Adelphi which preserve this old form of decoration—long vertical mouldings extending from the ground to the uppermost story. The illustration is from a contemporary print.

† The view of the front of the building is from a drawing by Mr. Howard Penton. It shows no changes since the house was built.

‡ The Embankment was commenced in 1862 and opened in 1870.



THE SOCIETY'S HOUSE, A.D. 1911.

and recently a third one was constructed on the second floor. Otherwise the two houses are separate and distinct. The last secretary to live on the premises was Sir George Grove.

No structural alterations of any importance seem ever to have been made in it. In 1815 the old skylight in the meeting room was altered, the existing lantern being substituted for the original oval light. The position of the platform and the chairman's seat in the meeting room were altered in 1863, when certain repairs were carried out in connection with the grant of a new lease (for thirty years), dated Lady Day, 1867. Originally they were on the north side of the room, facing the entrance. They are now on the east side. The reason of the change was to give greater facility of access from the offices to the officials' seats. The old arrangement was inconvenient in this respect, but in all other respects it was certainly better.* The present decorations of the ceiling, which were designed and executed by Messrs. Crace, are of the same date. At the same time the existing glass cases in the lower room—which was originally designed for the "Repository" of the Society's collection of mechanical inventions—were substituted for the pillars which previously gave apparent support to the ceiling and to the floor of the room above. This change had nothing to recommend it, and should never have been made. The appearance of the room as it was originally designed was much better, and the present cases are at once ugly and useless.†

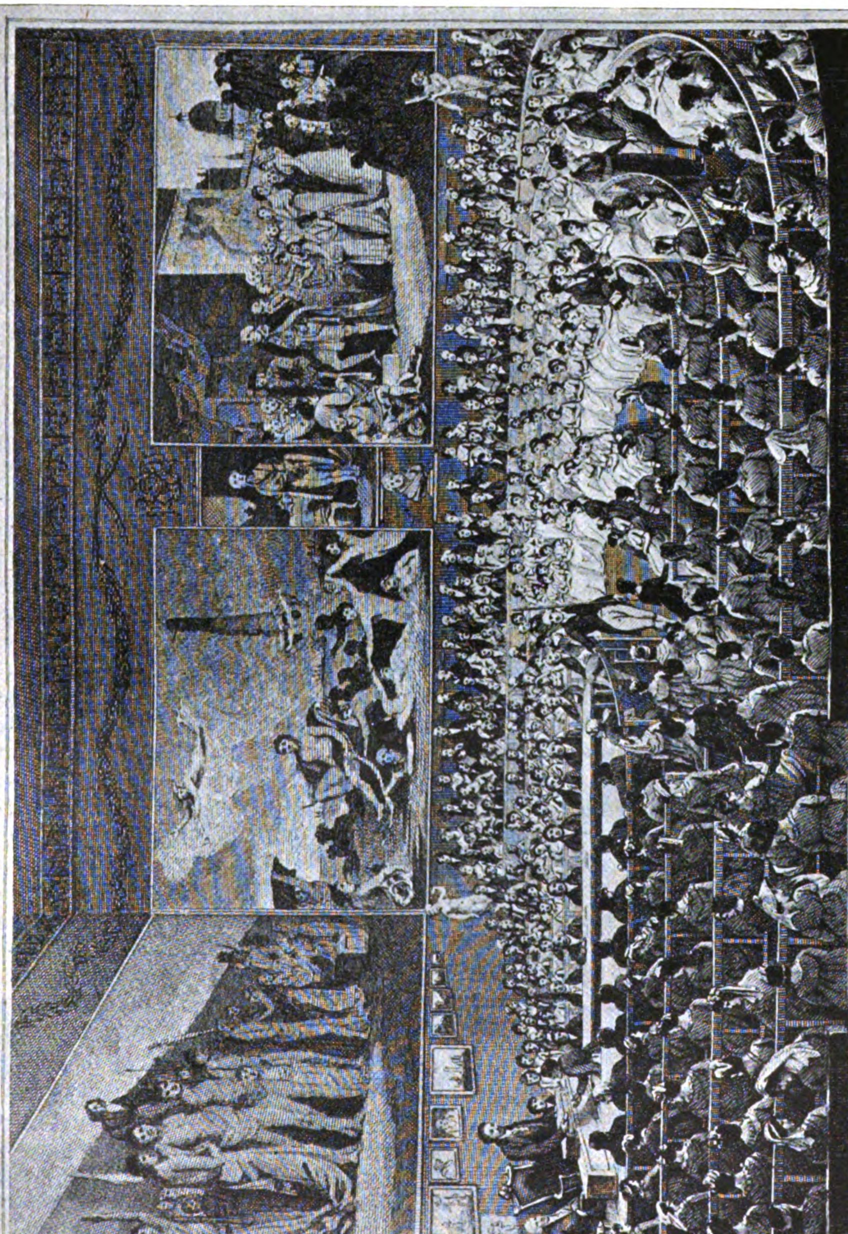
In 1847 the mosaic pavement in the entrance hall was presented by Messrs. Minton (then Minton and Blashfield); it is interesting as being one of the earliest examples of the application of mechanically produced tesseræ under Prosser's patent, afterwards the foundation of an extensive industry. The glass mosaic on the staircase was laid down in 1874 by Messrs. Powell. This, again, was one of the first uses of a novel and ingenious method of manufacture, though it had previously been utilised in one of the staircases of the South Kensington Museum. In 1877 the existing heating apparatus was introduced. Previously the meeting room had been very inefficiently warmed by furnaces in the basement, the heated air from which passed through gratings into the library, and thence by other gratings into the meeting room. In 1882 electric light was first installed. The current was obtained from a Siemens dynamo driven by a gas-engine, both being placed in one of the cellars. Later a storage battery (E.P.S.) was added. The cost of the installation was met by a subscription from past and present members of the Council. In 1899 this private installation was given up, and the current was taken from the then newly-established street mains. The above account is believed to include practically all the alterations of any importance since the original building of the house.

In 1774, when the Society was about to move into its new house in the Adelphi, the question of the decoration of the Great Room naturally gave rise to a good deal of discussion. It was determined that it would be desirable to procure "proper historical or allegorical pictures," to be painted by the most eminent artists. Further, it was decided that there ought to be eight historical and two allegorical pictures; that the subjects of the historical pictures should be taken from English history, and that the allegorical pictures should be "emblematick designs relative to the Institution and views of the Society." A proposal was accordingly made to eight artists, that they should paint each a historical picture, and to two others that they should paint allegorical pictures, the conditions being that they should not be paid, but should receive the profits arising from an exhibition of the pictures, to be held for four months. The historical painters were Angelica Kauffman, Sir Joshua Reynolds, West, Cipriani, Dance, Mortimer, Barry, and Wright; the allegorical painters, Romney and Penny. Mr. Valentine Green, the engraver, was requested to communicate with the selected artists, and to report their answer. Unfortunately, the answer—mainly, it appears, owing to Sir Joshua Reynolds—was a refusal. The portraits of the first two presidents of the Society, Lord Folkestone and Lord Romney—the first by Gainsborough and the second by Sir Joshua—were placed over the two chimney-pieces, and there the matter rested for a while.

Three years afterwards, viz., in 1777, Barry authorised the same Mr. Green—a member of the Society who took a very active interest in its welfare, and who afterwards received a gold medal on that account—to inform the members that one of the Royal Academicians they had applied to was willing to take the whole work upon himself, and to decorate

* The illustration shows the arrangement of the room in 1804. It is copied from a print in the Crace Collection, now in the British Museum.

† The picture (p. 1017) of the "Model Room," or "Repository," is copied from a print in Knight's "London" (1843), and shows very well the difference between the room as it now is and as it was originally built.



The Society of Arts distributing its premiums.

Published Aug. 21. 1809 by Richard Phillips, 71 St Paul's Church Yard.

the Great Room "with a series of pictures analogous to the views of the Institution." It was estimated that the canvas, frames, and colours would cost £100, and there was a further expense of £30 for models, which the artist offered to discharge, but which was eventually paid by the Society. The proposal, made at an ordinary meeting of the Society, was referred to the committee of "Polite Arts." The committee considered and accepted it before it was known who the artist was to be, and thereupon the chairman produced a letter from Barry, stating that the offer was his. Barry was then young and little known, full of confidence in his own powers, and assured that nothing but opportunity was wanting for him to make a reputation. Nor were his objects wholly personal. He was impressed—as well he might be—with the degraded condition of English Art, "fitted for nothing greater than portraits, and other low matters, from whence no honour could be derived either to the artist or the country"* and he believed that the production of "some great work of historical painting" would refute the assertions of those foreign critics who declared English painters to be incapable of any permanent work, and would also serve as an example to his countrymen. Feeling at once the necessity of the work, and the capacity within himself for executing it, he set himself to do it, without, as it seems, considering or caring even how he was to live during all the years so long a task must occupy.

On the whole, his hopes of fame were realised, for such reputation as Barry now possesses rests entirely on the great pictures he painted for the Society. The man himself was of a strange character, his life was by no means happy. An artist of considerable power, his powers were yet not equal to his own estimation of them; and his life, like that of Haydon, a few years later, was embittered by what he considered a lack of appreciation of his deserts.

He was born at Cork in 1741. The ability he showed in various early pictures gained him the notice of Burke, who assisted him in various ways, and gave him an allowance of £50 a year to visit Rome. In 1770 he returned to London, and in 1771 he exhibited his first picture at the Royal Academy—the "Adam and Eve" now belonging to the Society. It was in 1777 that he began his great work, the pictures in the Society's meeting room. In 1782, after they were completed, he was appointed Professor of Painting to the Royal Academy. His career in this office was by no means happy. He seems to have been afflicted with an irritable, cross-grained temper, and this led him into disputes with everybody with whom he came in contact. He quarrelled with the artists at Rome; with everybody who criticised his pictures; with his pupils; and with many influential friends who tried to assist him. Finally, he quarrelled with the Royal Academy itself, so that he was expelled from it in 1799. He grumbled at the Society, which seems to have treated him with sufficient liberality, for it had either given him, or assisted him to procure by exhibitions, a sum amounting altogether to £700, while the members of the Society raised £1,000, and purchased an annuity of £120; but, unfortunately, only a month before his death.

He died under very miserable conditions. After his expulsion from the Academy, he seems to have supported himself mainly by the sale of his etchings from his own works. He was taken ill in an eating-house near his home, in Castle Street, Oxford Street; and, his own house being locked up, he was carried to that of a neighbour, where he died on February 22nd, 1806. Even in his death his morose nature was shown, for he locked himself in for forty-eight hours, refusing medical aid; and this, when it did come, came too late. When his works were sold at Christie's, in 1807, they fetched very fair prices, the "Adam and Eve" being purchased for 100 guineas. One of them, however, the "Pandora," which brought, though unfinished, 230 guineas, when resold in 1846, to pay the expense of warehouse room, only fetched 11½ guineas. His body was placed in the Society's Great Room for a day before it was carried to St. Paul's, to be laid beside that of Reynolds.*

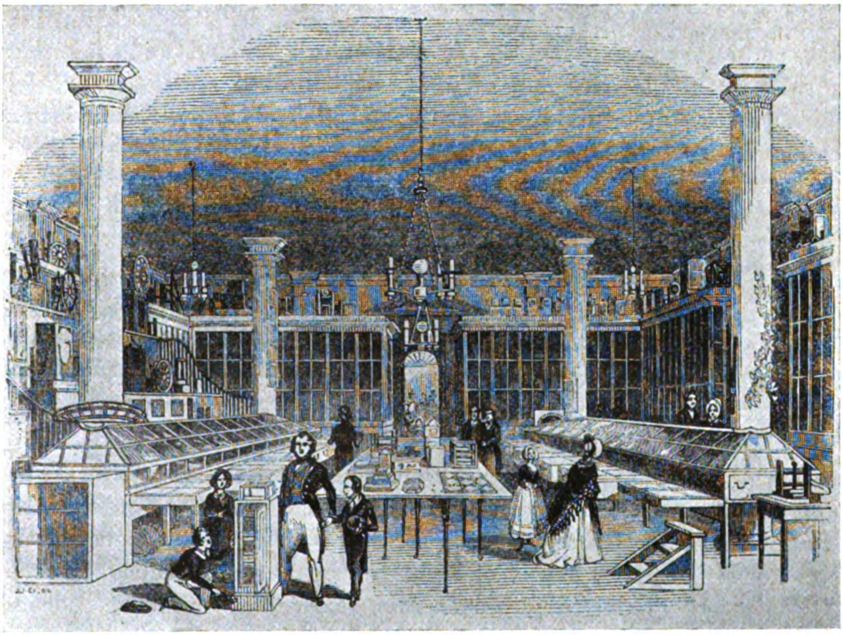
When Barry began his task he had, it is said, only sixteen shillings in his pocket, and he supported himself while it was in progress by etching. He applied to patrons, principally members of the Society, for a loan to assist him while he was at work, but it does not appear whether his applications were successful. The exact date at which the work was commenced is

* "An Account of a Series of Pictures in the Great Room of the Society of Arts . . . . By James Barry, R.A., Professor of Painting to the Royal Academy. London: Printed for the Author, by William Adlard, Printer to the Society . . . ." 1783.—*Introd.*

* Further information about Barry's life is given in S. Redgrave's "Dictionary of Artists of the English School." A longer life, written by the late S. T. Davenport, for a Dictionary of Painters, was printed in the Society's *Journal*, Vol. XVIII. p. 803. There is also a life in the "Dictionary of National Biography." In 1880, Mr. J. Comyns Carr read a paper before the Society on "The influence of Barry upon English Art." *Journal*, Vol. XXIX. p. 20.

not stated in the Society's Minutes, but the pictures were well advanced by the recess of 1778, when the key of the Great Room was entrusted to Barry, in order that he might work without interruption; and the work was continued until October, 1781. During its progress the Society's meetings were at first held in the Great Room, the pictures being covered up with canvas; but in 1781 the meetings were held in the committee room—*i.e.*, the present council room—the Great Room being given up entirely to the artist. In the same year, frames, designed by Barry himself, were procured from Mr. Adrian Maskens, of Compton Street Soho, at the expense of £100 17*s*. These frames are those in which the pictures now are, though they have, of course, been regilt since they were first put up. Not much information as to the progress of the pictures is given in the Society's Minutes. There are occasional references to the work, and payments on account of expenses incurred are authorised from time to time.

A suggestion made by the painter, that some portraits of members of the Society should be introduced gave rise to considerable discussion, and seems to have exercised the minds of the committee of "Polite Arts" for some time, but eventually a selection was made. As soon as the work was finished, a public exhibition of the pictures was held for the painter's benefit. They were shown for two months during 1783, and for the same time during 1784. The cost of these two exhibitions was defrayed by the Society, and amounted to £174. 6,441 persons attended the first exhibition, and 3,511 the second, among them being Jonas Hanway—the introducer of umbrellas—who was so pleased with the pictures that he showed his gratification by the very practical step of changing the shilling he had paid for admission for a guinea as he left. The exhibitions produced £503 12*s*. Congratulations poured in upon the artist, accompanied in some few cases at least by subscriptions or orders for paintings. But the measure of praise his pictures received was by no means equal to the artist's estimate of their deserts. In a letter, dated October 1784, to the president and members of the Society, we find him complaining bitterly of this want of taste on the part of the public. Sixteen or eighteen thousand pounds had, he says, been squandered that year at Westminster upon a "Jubilee of hackney'd German musick," "an empty hubbub of hundreds of fiddles and drums, which was dissipated in the air as soon as performed." This, too, had been attended by "well-dressed people of the first rank and condition, great Lords and Ladies with white wands, blue ribbans, and medals." Meanwhile his pictures, which were to have revolutionised English art, were being neglected in the Adelphi.



THE SOCIETY'S "REPOSITORY," A.D. 1843.

A full account of the pictures is given in

Barry's own work, above referred to. A shorter account was printed in the third volume of the Society's *Transactions* (1785), and this has been since republished in the *Journal*, with alterations, Vol. XVI. p. 604. Various other descriptions have been printed at different times, but they all seem to be derived, either directly or at second hand, from Barry's book. The whole series of pictures was intended "to illustrate this great maxim or moral truth—viz., that the obtaining happiness, as well individual as public, depends on cultivating the human faculties. To prove the truth of this doctrine, the first picture exhibits mankind in a savage state, full of imperfection, inconvenience and misery. The second represents a Harvest Home, or Thanksgiving to Ceres and Bacchus. The third, The Victors at Olympia. The fourth, Navigation, or the Triumph of the Thames. The fifth, the Distribution of Rewards by the Society. And the sixth, Elysium, or the State of Final Retribution. Three of these subjects are truly poetical, the others historical." *

The height of all the pictures is the same, 11 ft. 10 ins. The first, second, fourth, and fifth, being those at the ends of the room, are each 15 ft. 2 ins. long; the third and sixth, which occupy the north and south sides of the room, are each 42 ft. long. They all take up the upper portion of the wall, leaving a space beneath them of 10 ft. 6 ins. down to the ground.

The description of the pictures is too long for repetition, though its quaintly serious style makes it worth consultation. It may, however, be desirable to try to give a very brief explanation of the meaning of the pictures, for the use of those who care to follow out the story they are meant to tell. The first picture, the "Orpheus," is on the left-hand side of a person entering the room, and occupies the southern half of the west wall. It is intended to represent a savage people, living in a wild and desert country, while Orpheus is explaining to them the advantages of culture.

In the second picture, "A Grecian Harvest Home," we have the second, or agricultural, stage of civilisation.

The third picture, "The Victors at Olympia," which faces the visitor as he enters, is typical of the most advanced culture. At the right † of the picture, the conquerors in the games are receiving the prizes at the hands of the judges. Two of the athletes are carrying their father, Diagoras, a former victor. Near this group is another, the chief person in which is Pericles, who has borrowed the face of the Earl of Chatham. The personage in the chariot is Hiero of Syracuse; the leader of the chorus is supposed to be Pindar; the statue at the right end of the picture is Minerva; that at the other end is Hercules. The figure seated at the base of the statue of Hercules represents Barry himself

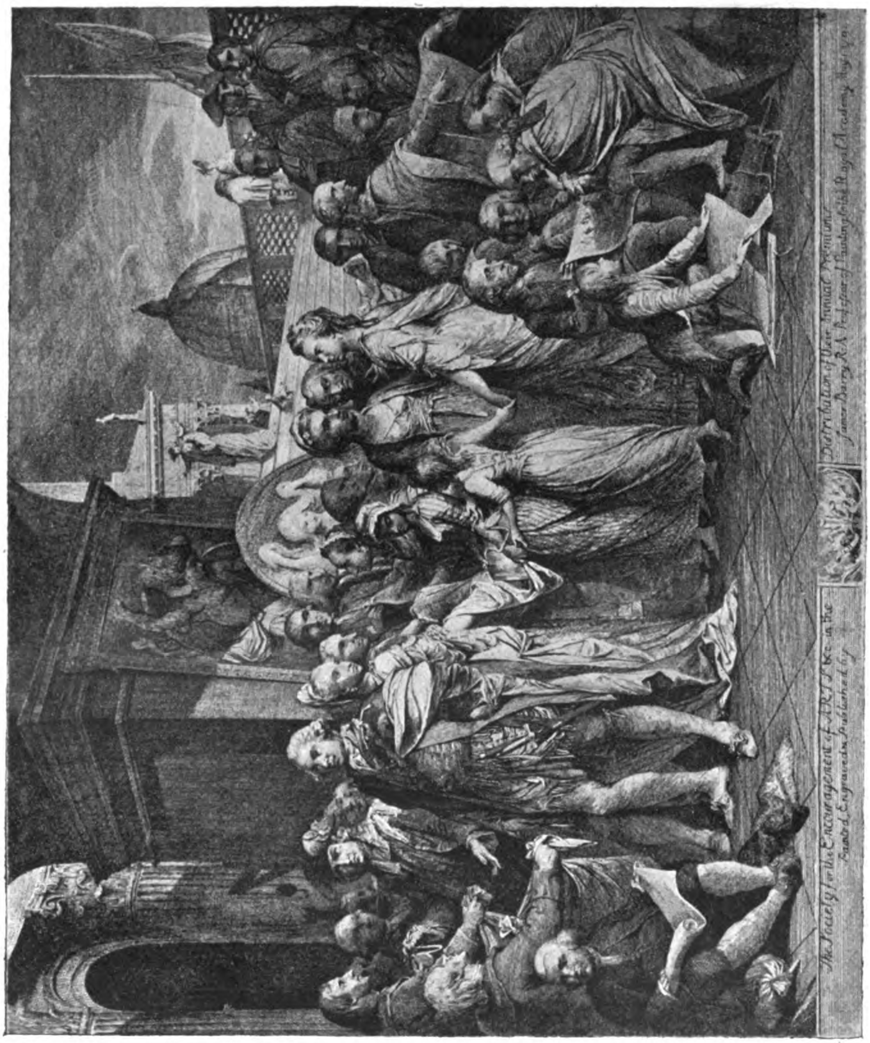
The fourth picture, "The Thames," is emblematical of the triumphs of modern commerce. The central figure represents Father Thames sitting in a triumphal car, steering with one hand, and holding in the other the mariner's compass. The car is borne along by Sir Francis Drake, Sir Walter Raleigh, Sebastian Cabot, and "the late Captain Cook, of amiable memory." In the front of the car are four figures, representing Europe, Asia, Africa, and America. Mercury, "the emblem of commerce," is represented at the top of the picture as summoning the nations, and the Nereids following the car carry several articles of the principal manufactures of Great Britain. "The sportive appearance of some of these Nereids gives a variety to the picture, and is intended to shew that an extensive commerce is sometimes found subversive of the foundation of virtue." In order to introduce the personification of music into "this scene of triumph and joy," the artist has placed amongst the sea-nymphs "his friend Dr. Burney, whose abilities in that line are universally acknowledged." "This," remarks a writer in the "Microcosm of London" (1809), was "a whim equally absurd and incomprehensible which no raillery or good counsel could induce him to dismiss from his canvas."

The fifth picture—"The Society" *—represents a distribution of the rewards in the Society. The figure near the left in nobleman's robes is Lord Romney, who was president when the picture was painted; near him is the Prince of Wales (George IV.); sitting at the corner of the picture, with a manuscript in his hand, is William Shipley, the originator of the Society; one of the farmers carrying specimens of grain is Arthur Young; the figure near him, holding a pen, is Mr. More, the then secretary. On the right of Lord Romney is the Hon. Charles Marsham, one of the Society's vice-presidents; on the left is another vice-president, Mr. Owen Salusbury Brereton. About the centre of the picture is "that distinguished example of female

* *Transactions*, Vol. III. p. 110.

† In every case *right* and *left* mean right and left of the spectator.

* The illustration is taken from Barry's etching, not from the painting, and the two vary considerably. The description in the text corresponds with the painting.


The Society for the Encouragement of ARTS &c. in the
Painted Engraved & Published by
Distribution of their Annual Premiums
James Barry R.A. Professor of Painting to the Royal Academy

excellence, Mrs. Montague, who long honoured the Society with her name and subscription." Near her are the Duchess of Northumberland, the Duke of Northumberland, Joshua Steele, Sir George Savile, Dr. Hurd, Bishop of Worcester, Soame Jenyns, James Harris, and the two Duchesses of Rutland and Devonshire. Between these ladies "the late Dr. Samuel Johnson seems pointing out this example of Mrs. Montague to their graces' attention and imitation." Further to the left is the Duke of Richmond, and near him Edmund Burke; still nearer the right side of the picture are Edward Hooper and Keane Fitzgerald. The Duke of Northumberland, the Earl of Radnor (the second Earl), William Locke, and Dr. Hunter are examining some drawings by a youth. Near the right side of the picture are Lord Folkestone, first president of the Society, his son, the first Earl of Radnor, and Dr. Stephen Hales. The introduction of Somerset House and St. Paul's Cathedral is intended to show that the Society is in London; the picture (Barry's "Fall of Satan") and the medallion represent the arts of Painting and Sculpture.

The sixth picture represents "Elysium, or the State of Final Retribution." In it are "brought together those great and good men of all ages and nations, who have acted as the cultivators of mankind."

According to the account in the *Transactions*, the first group on the left consists of Roger Bacon, Archimedes, Descartes, and Thales; behind them stands Sir Francis Bacon, Copernicus, Galileo, and Sir Isaac Newton; near these is Columbus with a chart of his voyage; and close to him, Epaminondas with his shield, Socrates, Cato the younger, the elder Brutus, and Sir Thomas More. Behind Brutus is William Molyneux, holding "his book of the Case of Ireland"; near Columbus are Lord Shaftesbury, John Locke, Zeno, Aristotle, and Plato; and in the opening between this group and the next are Dr. William Harvey, the discoverer of the circulation of the blood, and Robert Boyle. King Alfred is leaning on the shoulder of William Penn, who is showing his code of laws to Lycurgus; standing round them are Minos, Trajan, Antoninus, Peter the Great of Russia, Edward the Black Prince, Henry the Fourth of France, and Andrea Doria of Genoa. Then come patrons of genius, Lorenzo de Medici, Louis the Fourteenth, Alexander the Great, Charles the First, Colbert, Leo the Tenth, Francis the First, the Earl of Arundel, and "the illustrious Monk Cassiodorus"; behind the archangel are Pascal and Bishop Butler, behind whom again is Bossuet, his hand resting on the shoulder of Origen. Behind Francis the First and Lord Arundel are Hugo Grotius, Father Paul, and Pope Adrian.

"Near the centre, towards the top of the picture, sits Homer, on his right hand Milton, next him Shakespeare, Spenser, Chaucer, and Sappho; behind her sits Alcæus, who is talking with Ossian; near him are Menander, Molière, Congreve, Bruma, Confucius, Mango Capac, &c. Next Homer, on the other side, is the Arch Bishop of Cambray, with Virgil leaning on his shoulder; and near them Tasso, Ariosto, and Dante. Behind Dante, Petrarch, Laura, Giovanni, and Boccaccio. In the second range of figures, over Edward the Black Prince and Peter the Great, are Swift, Erasmus, and Cervantes; near them Pope, Dryden, Addison, and Richardson. Behind Dryden and Pope are Sterne, Gray, Goldsmith, Thompson, and Fielding; and near Richardson, Inigo Jones, Sir Christopher Wren, and Vandyke. Next Vandyke is Rubens, with his hand on the shoulder of Le Sueur; behind him is Le Brun; next are Giulio Romano, Dominichino, and Annibale Carracci, who are in conversation with Phidias, behind whom is Giles Hussey. Nicolas Poussin and the Sicyonian maid are near them, with Callimachus and Pamphilus; near Apelles is Correggio; behind Raphael stand Michael Angelo, and Leonardo da Vinci; and behind them Ghiberti, Donatello, Masaccio, Brunaleschi, Albert Durer, Giotto, Cimabue, and Hogarth. In the other corner of the picture the artist has represented Tartarus, where, among cataracts of fire and clouds of smoke, two large hands are seen; one of them holding a fire-fork, the other pulling down a number of figures bound together by serpents, representing War, Gluttony, Extravagance, Detraction, Parsimony, and Ambition; and floating down the fiery gulph, are Tyranny, Hypocrisy, and Cruelty, with their proper attributes."*

It is stated in the *Transactions*, Vol. XXIII. p. 18, that on the death of Lord Nelson in 1805 "the Society proposed to commemorate that hero by introducing his portrait in one of the pictures which decorate the Great Room," and Barry undertook to execute the work, but his death prevented the design from being carried into execution.

The six pictures did not occupy the whole wall of the room, the spaces over the chimney-pieces at either end being filled by the portraits of Lords Romney and Folkestone, before referred to. It does not appear that Barry's original design included pictures for these spaces, but we find him, in 1801, expressing a wish that these two portraits should be placed in

* *Transactions*, Vol. III. p. 128.

some other room of the Society, and that he should be allowed to execute pictures which might fill the vacant spaces. This he was willing to do without charge, and without interruption to the business of the Society. The cost of them would not, he said, exceed £10 for canvas and stretchers. It may be supposed, and indeed it appears from the style of the letter, that he was, at that time, perfectly well satisfied with the treatment he had received from the Society, for he expresses himself as being "both gratified and flattered with the publick reputation of the pictures." Permission was given to Barry to carry out his scheme, and it may be presumed that it was upon the receipt of such permission that he prepared the two designs which are still preserved amongst his etchings, representing George the Third and Queen Caroline. But, although the proposal was at first readily accepted, it seems to have given rise to some difference of opinion, for the then president, the Duke of Norfolk, notified his intention of moving to rescind the resolution of the Society for the removal of the portraits. Under these circumstances, Barry at once withdrew his offer, at the same time disclaiming any intention to show disrespect to the memory of the first two presidents of the Society. He urges very fairly that another position might be found for the pictures, which would be in no way injured, and that his design could then be harmoniously completed. Coming from a man of his temper, it must be allowed that his second letter is most dignified, and in excellent taste. The portraits consequently remained in their places until 1864, when they were removed to make way for the portraits of the Prince Consort and the Queen, by J. C. Horsley, R.A., and W. C. Cope, R.A. These, with the bust of Prince Albert now standing in the ante-room, form the memorial which was provided in 1863 by subscriptions from members of the Society in memory of their president.

It is needless to say that these celebrated pictures have always been an object of great care to the Society. Looking through the Minutes since the commencement of the century, we find constant references to the attention bestowed upon them. In one place, instructions are given to the housekeeper that they should be carefully wiped down every year; in another we find West, and later on Mulready, reporting on their condition. The frames were regilt several times, and so on. The pictures have been cleaned at various times; about 1834 it is said that a thick coat of olive oil, which had been applied to them under some mistaken notion of preserving them, was removed. In 1846, when the room was redecorated by Hay, of Edinburgh, the way in which the pictures had been treated called forth a good deal of adverse criticism, and it was then that Mulready was called in to report upon them. His report was that they were in excellent condition, and that nothing appeared to have been done to them which had inflicted the slightest injury. This opinion was confirmed by the opinion of Seguier, the picture restorer. "The Orpheus" had, either then or at some previous time, been badly varnished, and stains from this treatment are still perceptible. In 1863 they were relined and stretched upon new frames by Merritt, a well-known picture cleaner, at a cost of £220. In 1880 they had got to be extremely dirty, and they again underwent a thorough cleaning. Since that date they have been cleaned every year.

Besides the pictures in the Great Room, the Society possesses the plates of a number of etchings by Barry, most of which were presented to the Society in 1851 by Miss Barnett. Some of these may have been done while he was at work upon the pictures, but most of them probably during his later years. Six of them represent the six pictures. They were etched after the completion of the pictures, and were copied from the originals by the artist himself, yet, curiously enough, they differ in many of the details from the paintings. It is true that some slight alterations were made by Barry in the pictures after they were first painted, but this does not seem sufficient to account for all the variations. The other etchings are nearly all from pictures of the artist, most of which are no longer extant. The Society also possesses Barry's "Adam and Eve," one of his more important works, which, as above mentioned, was sold after Barry's death at Christie's. It was presented to them by Mr. R. H. Solly. This picture has been for some years on loan at the Victoria and Albert Museum. There is also a portrait of Barry, painted by himself, which is hung up in the ante-room, and an oil painting which is said, it is not known on what authority, to be a portrait by him of his mother. The former was presented to the Society by Mr. W. Moffat. There seems to be no record in the Society's Minutes of the way in which the latter picture came into the Society's possession, and there is much doubt as to its authenticity.

Besides the pictures above mentioned, the Society possesses the following portraits:—

Full-length painting of Jacob, Viscount

Folkestone, first president of the Society of Arts, by Thomas Gainsborough, R.A. This picture was painted by Gainsborough in 1776. It was a copy of a three-quarter portrait by Hudson (1749); enlarged to full length by Gainsborough to match the portrait of Lord Romney. The fee paid to the artist was a hundred guineas. Dance had previously been asked to do the work, and had undertaken to do so, but eventually was unable to carry out the commission.

Full-length painting of Robert, Lord Romney, second president of the Society of Arts, by Sir Joshua Reynolds, P.R.A. This portrait was painted for the Society in 1770. The price paid to Sir Joshua Reynolds was 150 guineas.

Portrait of William Shipley, "whose public spirit gave rise to this Society." Painted by Richard Cosway, R.A., and presented by him to the Society in 1785, through the intervention of Caleb Whitefoord, V.P.

Portrait of Peter Templeman, M.D., secretary of the Society from 1760 to 1769. Painted by R. Cosway, R.A., and presented by Caleb Whitefoord, V.P.

Portrait of Samuel More, secretary of the Society from 1769 to 1799, by Benjamin West, P.R.A. This was painted for the Society in 1796. The amount paid the artist was £66 8s.

Portrait of Sir Frederick Bramwell, Bart., president of the Society in 1901. Painted after Sir F. Bramwell's death by Seymour Lucas, R.A., and presented to the Society by H. Graham Harris, V.P., in 1904.

Portrait of Sir Henry Trueman Wood, secretary of the Society from 1879. Painted by Sir Hubert von Herkomer, R.A., and presented by the members of the Council in 1902.

Portrait of Dr. Frederick Crace Calvert, F.R.S. Presented by Mrs. Calvert (1876). He delivered several courses of Cantor lectures—the first in 1864.

Portrait of Miss Ann Birch Cockings, housekeeper and registrar of the Society (1802–1844). Painted and presented to the Society by Miss E. A. Drummond (1882). Miss Cockings was a personage in her time, and apparently a lady of some humour. She is said to have retorted to an importunate applicant who wanted to interview the secretary, that "one old woman ought to do as well as another."

The bust of the Prince Consort has already been mentioned. This was the work of William Theed, a sculptor of some repute in the last half of the nineteenth century. He was employed to produce statues and busts of numerous eminent persons, and his work is to be found in Westminster Abbey, at Windsor, in the London Guildhall, and also in Calcutta, Manchester, Liverpool, and elsewhere. His best-known work is the colossal group representing Africa, at the north-east angle of the Albert Memorial. He was born in 1804, and died in 1891.

The statue at the foot of the staircase is of Joshua Ward, a well-known character in his time (1685–1761). Ward, known as "Spot" Ward from a mark on his face, was a quack doctor, who amassed a large fortune by the sale of his remedies. In his later life he was very popular, and had many patrons, including George II. In 1740 he introduced into England an improved method of manufacturing sulphuric acid, already practised on the Continent, and set up works for the purpose at Twickenham and Richmond. The process was afterwards perfected by Roebuck. The statue is by Agostino Carlini, and was presented to the Society in 1792 by Ralph Ward, Ward's grandnephew, and one of his heirs.

The Society also possesses a bronze bust of Sir George Birdwood by Alfred Gilbert, R.A., a replica of one presented in 1900 to the University of Bombay by some Indian friends of Sir George, and a terra-cotta bust of Sir Edwin Chadwick, the well-known sanitary reformer (1800–1890), by George Tinworth. It was presented to the Society by his daughter in 1905.

THE ANCIENT FRESCOES AT CHICHEN ITZA.*

The ruins of Chichen Itza in Yucatan are amongst the most important in Central America, being especially remarkable for the number of coloured portrait sculptures and frescoed walls. The frescoes have been sadly destroyed in the course of centuries, but enough remain to provide striking pictures of the life of the ancient folk. In two of the upper rooms of the building called the Nuns' Palace, the walls and vaulted ceiling were entirely covered with scenes which had backgrounds with thatched houses and trees, also temples with high-pitched roofs enclosed within battlemented walls. There were groups of warriors armed with spears, *atlatls* (throwing sticks), and round shields, and others seated on the ground, with ornamental tails hanging from their girdles. The drawing was firm and spirited, the colouring vivid and harmonious.

Stephens observed a row of Maya glyphs painted just below the vaulting in the interior of the small building known as the Iglesia, but they have disappeared, and there are no signs of any glyphs

* Abstract of a paper read by Miss A. C. Breton before the Anthropological Section of the British Association at Portsmouth, 1911.

among the paintings at Chichen Itza. The chambers of the Akaboib have been whitewashed in modern times, and only a blue band along the edge of the vault is now visible. In the narrow corridor of the Caracol, too, very little colour is left.

The building at the south end of the eastern wall of the great Ball Court, usually called Temple of the Tigers, contains in its upper part the best preserved paintings yet discovered. The outer chamber having been filled with débris owing to the fall of the roof when the wooden lintels gave way, the inner chamber also became partly blocked and difficult of access, until Dr. Le Plongeon in 1884 cleared away most of the accumulated material, and partly copied the paintings in it. Visitors wrote their names over the frescoes, bats lived at one end, swallows at the other, and bees made tunnels in the plaster. Still it has been possible to secure many of the details, and to give some idea of the composition. The chamber is about 26 feet long, and not quite 8 feet wide, and 22 feet high to the top of the vault, with the door in the middle of the long western side. Each of the long sides is divided into three panels, of which the four end ones represent landscapes full of armed warriors, as do those of the north and south sides, with houses above, and tents and temporary buildings below, where chiefs are consulting and priests perform rites of divination. These panels are divided by a blue band from a dado with mythological figures and plants.

The south-west end is the most complete, and has about 120 figures, almost all of them placed at certain distances and angles from each other. These distances were measured from the point where the nose of each figure appears above the shield, and form the basis of the composition. The position of the shields fixed, the artist then drew the figures according to his fancy, and no two are alike. In this scene the attacking party are distinguished from the defenders of the village above by a difference in costume. The former have cotton knee and ankle bands, small green shields at their backs with hanging streamers, and round green earrings and necklaces. Their head-dresses, surmounted by long feathers, are more elaborate than those of the villagers. The latter have a round, stiff headpiece with two or three blue feathers standing up from it, oblong ear ornaments which pass through the elongated lobes, white shirts and round shields, usually with a crescent in the centre as device. All cast their spears from *atlatls*. The chiefs, who sit in consultation below, have feather mantles like those of the portrait statues which supported the sculptured table in the outer chamber.

The narrow south end panel also has a scene of attack, with high scaffold towers and a ladder of a notched tree-trunk, on which some of the assailants are perched. Here the men are taller and more athletic than in the previous scene. In the following panel there are more important houses, forming a town, with a forest on both sides, in which are animals, snakes and birds. Beyond come the Red Hills on which wilder figures are grouped, with rocks and trees below. The north end is much destroyed, but some personages on a background of blue sky may represent departed heroes. The shields in this are oblong. The last of these scenes shows a group of houses inside a defensive barrier, and blue warriors in feather cloaks have conquered the inhabitants. Above the door a life-size recumbent figure may be the hero in whose honour the building was erected.

INDIA WITH RESPECT TO THE WORLD'S COTTON SUPPLY.*

Shortage of raw cotton has become an almost chronic condition with which the cotton manufacturer has to contend. It has produced abnormally inflated prices, given an opportunity to cotton gamblers, caused loss and embarrassment to manufacturers, and produced distress among cotton operatives. "Shortage" has not been produced by a falling-off of the world's output of raw fibre, nor by an increased demand by Lancashire for cotton, but by an enormous growth in the manufacture of cotton goods on the Continent of Europe and in the United States of America. In eighteen years prior to 1910 Britain's demand for raw cotton has fallen 4 per cent., while during the same period Europe's requirements have increased 70 per cent., and this on a figure much larger than ours. America, during the same time, has increased her demand 90 per cent., and her total consumption of fibre now exceeds that of Britain by no less than 54 per cent. Thirty years ago the total American crop of cotton was less than seven million bales, but, supplemented by the small crops of other countries, was sufficient to supply the world's demands and leave a surplus each season, keeping the price reasonable and fairly regular. Now, with an American crop nearly double the figure just quoted, and with increased supplies from other fields, and with the demand of Lancashire stationary, the price of raw fibre has doubled, and "shortage" has become rampant, notwithstanding the restricted time worked in the mills. The difficulty apparently gets worse month by month, and unless measures of amelioration are successfully pressed, the cotton industry of Lancashire must decline, and ultimately be starved out of existence. India at present produces almost half the weight of cotton grown in the American fields, and has, roughly, 20,000,000 acres under cotton crops. Indian fibre is, however, of short staple and, therefore, very little used in Lancashire. Britain consumed only 87,592 bales during the year ending August 31st, 1910. Many experts believe that with properly directed effort the crop of Indian cotton may be doubled in the course of a few years. If this can be done, even if the staple

* Abstract of a paper read by Mr. J. Howard Reed, F.R.G.S., before the Section of Economic Science and Statistics of the British Association at Portsmouth, 1911.

is not improved, it will take the place of much long-fibred cotton now used throughout the world, and set free for Lancashire a proportionate amount of better material. The cultivation of cotton in India is very primitive. The lands are poorly tilled, inadequately manured, and meagrely watered; while the native farmer is not only very unprogressive, but is harried by unscrupulous money-lenders, crippled by poor seed, and handicapped by insect pests. With selected seed, longer-stapled cotton can be grown, but the native ryot finds it gives a lighter crop, and as he can under present conditions only obtain the same price as for the shorter-stapled cotton, he naturally soon reverts to the cultivation of short-stapled fibre. This is largely an economic difficulty, which can be met by the establishment of recognised buying and ginning centres, and the founding of co-operative credit banks, each under scientific and official control. The Agricultural Department of India has done much to improve matters, but larger grants are required to enable it to do more. There is enormous scope for its usefulness. The native people need to be taught better methods of farming, modern agricultural machinery should be introduced, proper rotation of crops insisted upon, ample manuring provided for, better seed made available, honest methods of financing established, and well-placed and easily accessible ginning and buying centres set up. If work of this kind is taken in hand in a thoroughly efficient manner, more acres can be brought under cultivation, and the number of cotton cultivators will multiply. The development of railways, roads, and irrigation works, already in a highly organised condition, will advance as the demand for them grows. India has in the past produced better cotton, and can do so again under properly regulated conditions. Any efforts which can bring this about are well worth making, as their success means vast advantage to the agriculturists of India, a relief from the present serious strain in the cotton world, and the salvation of the great industry of Lancashire.

AGRICULTURAL RESEARCH.

As the result of communications between the Board of Agriculture and Fisheries and the Development Commissioners, the Treasury have now sanctioned the allocation of funds—which, when the scheme is in full operation, will amount to £50,000 per annum—to be distributed by the Board for the purpose of promoting agricultural research.

The scheme provides for:—

1. A system of agricultural research which will secure for each group of the problems affecting rural industry a share of attention roughly proportional to its economic importance.

2. The concentration of the scientific work on each group at one institution or at institutions working in combination.

3. Grants for special investigations for which provision may not otherwise be made.

4. The grant of scholarships with a view to the increase of the number of men fully qualified to undertake agricultural research.

5. The carrying out of investigations into problems of local importance, especially those involving the application of modern research to local practice, and the provision of scientific advice for farmers on important technical questions.

In making arrangements for the separate investigation, as far as possible, of each group of allied subjects the Commissioners and the Board have been impressed with the importance of securing continuity in work which is necessarily of considerable duration, and at the same time of providing staffs of specialists and experts who will be permanently engaged on work arising from the investigation of the same group of problems. By this means concentration and economy of effort will be better secured than it would be if a number of institutions were dealing at the same time with the same group of problems.

It has been arranged that grants should be made for research in the following groups of subjects:—

1. Plant physiology.
2. Plant pathology and mycology.
3. Plant breeding.
4. Fruit growing, including the practical treatment of plant diseases.
5. Plant nutrition and soil problems.
6. Animal nutrition.
7. Animal breeding.
8. Animal pathology.
9. Dairying.
10. Agricultural zoology.
11. Economics of agriculture.

A sum not exceeding £3,000 per annum will be available for assistance in respect of special investigations for which provision is not otherwise made.

Grants from this fund will be made on the recommendation of the Board's Advisory Committee on Agricultural Science, who will consider not only whether the proposed investigation is desirable in itself, but whether it could not be better carried out at one of the special research institutions referred to above. The grants will be made from year to year, and will be for one year only in each case.

In order to secure the services of a number of carefully trained men for work in connection with the scheme, the Board propose in each of the years 1911, 1912, and 1913, to offer twelve scholarships, of the value of £150 per annum, tenable for three years. It is proposed that candidates for scholarships should be selected by a special committee representing the institutions under whom the selected candidates will subsequently work. The award of twelve scholarships will be conditional on a sufficient number of thoroughly suitable candidates presenting themselves.

Grants will also be made to certain universities, university colleges, and agricultural colleges in

England and Wales for the purpose of enabling them to supply scientific advice to farmers on important technical questions and to carry out investigations into problems of local interest, which can be more conveniently studied on the spot than at one of the research institutions.

By means of these grants it is hoped to provide an expert staff possessing both scientific and practical qualifications, who will devote themselves to solving difficult local problems and in other ways endeavour to secure the application of science to practice.

THE CATTLE-BREEDING INDUSTRY OF ARGENTINA.

Argentina ranks third in the world as a cattle-producing country. Russia and the United States alone lead it, but Argentina has only about six million inhabitants to feed, which accounts for the fact that it is the leading country in beef exports. Russia and the United States must consume most of what they produce. Argentina ships the greater proportion of what it produces ; not only oxen, but horses, sheep, wool, maize, wheat and flax-seed. At the last census, taken about two years ago, there were twenty-nine million cattle in Argentina and about six millions in Uruguay. This is, according to the International Bureau of the American Republics, nearly all stock of the best English blood—Shorthorn, Hereford, and Aberdeen Angus. Argentina and Uruguay cattle are reared under conditions somewhat peculiar to the locality. They are not range cattle, nor yet exactly farm cattle, and are given but little grain, yet the export steers of Buenos Aires or Montevideo are fully equal in size, and will cut as much prime beef and as little waste as the best steers of Kansas, Pennsylvania, or south-west Virginia in the United States. The word "estancia," which primarily connotes the central habitation, has come to include in the Argentine Republic the whole farm plantation, or ranch. The "estancias" are of all sizes, from the small farm of a few hundred acres to the large plantation of 30,000 or 40,000 acres. Only a few "estancias" are cattle or sheep ranches alone; they are grain farms as well. The cattle are fattened on cultivated grasses in permanent pastures. Alfalfa is the principal grass. When once properly set, alfalfa requires no replanting for ten years or more. As a general rule, cattle, up to the time of finishing for market, are given free range on the native grasses, or *pasto fuerte*. It has been estimated that the native grass in the outlying provinces will carry one ox to every six acres, or one sheep to the acre. In these distant pampas, the grass is not so good and water is scarce. Most of the cattle are brought down to the rich alfalfa pasturage nearer market, to be fattened. Land which will carry eight hundred animals to the league, or one to eight acres, when put into alfalfa will easily carry three thousand to the league. In the central provinces of Buenos Aires,Cordoba, Santa Fé, Entre Rios and Corrientes, the native grasses are better, and more alfalfa is grown. These five are the principal cattle-producing provinces, as they are also the principal grain-producers. Next to these come La Pampa, Santiago, and Salta, each of which has from seven hundred thousand to one million cattle. Then come San Luis, Mendoza, La Rioja, and Catamarca, averaging about half these numbers. In the north, Missiones, Formosa, and El Chaco, and in the south Rio Negro and Chubut, are rapidly becoming important cattle districts. Even San Juan and Neuquen, on the Andean slope, and Santa Cruz and Tierra del Fuego in the extreme south, are finding that cattle, as well as sheep, can be bred with profit. In fact, there is but little territory in the Argentine Republic which is not suitable for either cattle or sheep. Beef is exported from the La Plata region—salted or as meat extracts, and frozen in quarters. England is the principal market for South American beef. The frozen meat industry in the Argentine Republic has grown considerably during the last few years. In the year 1908 the Argentine Republic exported 60,916 head of cattle, three-fourths of which went to Chile. It exported 2,295,784 quarters of frozen beef, and from the salting works 155,400 beeves as salt beef, meat extract or jerked beef. In this latter industry, Uruguay exported 754,300, and southern Brazil 425,000 head respectively.

HOME INDUSTRIES.

Improving the Loom.—The *Manchester Guardian* describes a novel device for arresting the flight of the shuttle on a cotton loom—the joint invention of several Blackburn cotton men—that has just been patented. Instead of being hinged in the shuttle-box, the "swell," which is of the usual type, is allowed some freedom of movement in the direction of travel of the shuttle. A wedge at the back of the "swell" is held in position laterally by a spring, so that when the "swell" is carried along by the friction and motion of the shuttle, a gradually increasing hold is produced, and the shuttle is brought to rest without damage to the picker, the life of which, it is claimed, is thus very considerably increased. The operation of this device upon the shuttle renders it possible to dispense largely with checking and bumping straps, and it is claimed that the "travel" of the shuttle is so much improved that a better twist and weft weave is obtained. After an extended trial, the invention is now in regular use in about a dozen of the principal weaving sheds at Blackburn.

The Electrical Industry.—The electrical industry of the country cannot be said to be in a satisfactory condition, and there are many explanations of it. Among other things, it is complained that there

is no association which adequately represents the interests of the British electrical manufacturers as so many other industries are represented; an association to promote the consideration and discussion of questions affecting the electrical manufacturing trade, and generally to watch over, protect, and promote the interests of persons engaged in electrical manufacturing. The National Electrical Manufacturers' Association was founded some eight years ago to do all this, but hitherto, for one reason and another, it has not done all that was expected of it. It has failed to include in its membership many large and influential firms, and though it has done much useful work with the means at its disposal it has been crippled from the lack of adequate funds. It is now to be reorganised, and in future it will be known as the British Electrical Manufacturers' and Allied Trades' Association. The basis of subscriptions has been rearranged, it is expected that the revenue will be largely increased, it has appointed Mr. D. N. Dunlop, the sales manager of the British Westinghouse Electric and Manufacturing Company, as its secretary, and it will have its representatives in all parts of the world, sending information and assisting the British electrical manufacturer in ways that should lead to a much larger output of electrical apparatus in England. The programme of the reorganised association is said to have received the support of the leading electrical firms who have hitherto held aloof, and it may be hoped that this will tend to the good feeling towards each other which is so eminently desirable, but which has not always been existent, in the relations of electrical manufacturers towards each other.

The Coal Mines Bill.—It may be hoped that when this Bill is further considered by Parliament the clause which bars the internal-combustion locomotive from being introduced into collieries will be reconsidered. On the face of it, it seems undesirable to reject such a means of transport. These machines are largely used in continental and colonial collieries for underground haulage. They have been in use since 1903; their employment is becoming more general; they offer considerable economy to all mines, more especially to certain small mines which have been most affected by recent legislation; and the use of these machines is officially sanctioned by the German, Austrian, Belgian, and Dutch authorities. In the colonies, too, these machines are sanctioned and are at work. The Government appear to object to their introduction in British mines, fearing accidents, but if they can be used safely in foreign mines it is difficult to understand why they should be barred in this country, not merely in certain mines but in all. No doubt there would have to be stringent regulations governing their usage, as abroad, but it has not been demonstrated that the regulations cannot be enforced.

The Mining Industry.—The unrest in the mining industry continues, and in parts of Wales it has taken almost a revolutionary character. The Miners' Federation of Great Britain is opposed to a national strike on Welsh behalf, and some of their own leaders have advised the Welshmen to submit to the will of the Federation, but the men in certain districts seem to be quite out of hand. The treasurer of the South Wales Miners' Federation, supposed to be a moderate man, predicts a national strike for the minimum wage, but meanwhile the Coal Mining Association of Great Britain has agreed to meet the Miners' Federation of Great Britain to discuss the minimum wage question. The difficulty is to define an abnormal place, and to fix a general minimum. It is to be hoped that some solution of the problem will be found, and that anything like a national strike of miners will be avoided. Few probably realise the enormous injury that would be inflicted upon numerous home industries by the stoppage of normal coal supplies, even for a few days, and the small stocks of coal held by manufacturers and others controlling these industries.

Hop Drying.—The Germans have invented many hop-drying apparatus, but those that are satisfactory in other directions are usually barred upon the score of expense. A large capital expenditure for the drying of hops is not justified, but the need for some better system than that which is still general is apparent. Kentish growers are feeling the competition of German and American hops, which are often of superior quality to the English as a consequence of the better methods of drying in vogue in those countries. The criteria of well-dried hops are thus described by a writer in the *Times*:—To meet the brewers' requirements dried hops should contain about 10 per cent. of moisture. Apart from the fraud of selling them in too moist a condition, it is of great importance that they should not contain more than this amount, and that the contents of the packages, or "pockets," should be evenly dried throughout, else damage will be caused by mould-growths and changes which lead to heating. If the hops are too dry they will not stand handling well, and large losses of the valuable hop-resins have been traced to the friability of the dried hop cones, the leaves of which hold and protect the seeds around which the resins lie. The colour of the hops and their quality for brewing depend upon the heat treatment, the temperature employed, and the duration of the heating. The favoured colour appears to be green with a light amber shade. Too high a temperature, or too long an exposure, will give hops a poor colour and is apt to cause deterioration in the quality of the resin and to lessen its quantity.

Yeast.—Foreign competition continues to tell upon the yeast industry. For many years it has been a very profitable "side line" of the grain-spirit distillers and vinegar makers. At one time foreign competition was negligible, but of late Belgium, Germany, Holland, France and Denmark have become serious competitors, and about one-third of the yeast supplies comes from those

countries. The British output of yeast is approximately 16,000 baskets, of 56 lbs. each, a week, some 8,500 baskets being imported. The Belgian and Dutch yeast is of a low grade. The British output steadily increased until 1905, when foreign competition first became serious. The foreign maker is in a strong position, since he has a protected home market for spirits and is not trammelled by revenue restrictions. The British producer complains that he is precluded from separating more than 15 per cent. of yeast from his mash in a brewing period, although he can easily separate 20 per cent. without seriously reducing the output of spirit.

Railway Charges.—If in consequence of a readjustment of wages Parliament is to be asked to sanction increased freight charges, there is something to be said for the suggestion that it would be better to raise the passenger fares in certain directions. An increase of freight charges might seriously hamper trade, but passengers might well pay a little more for the services they enjoy. The great improvements in the railway service of recent years have benefited neither the companies nor the employees, the benefit has gone to the passengers. They have much more luxurious travelling at much cheaper rates than formerly, at rates that are really too low. It is with some of the railway services as with the omnibus companies. The public are given too much for their money. Assuming that, as a result of the recommendations of the Commission now sitting, the railway companies have to pay their employees higher wages, it might be better if they put up passenger rates to some extent, and on certain services, rather than add to freight charges, which as they stand greatly handicap home traders in competing with the foreigner—much more favourably placed. The only railway freight rates which railway companies can increase without immediate danger of losing revenue are those on traffic absolutely dependent on the railway service, and this is already paying rates relatively higher than traffic which can get to its destination by alternative means of transport. The charges on mineral traffic may seem to admit of some increase, for it is still carried at very low rates, but the principal mineral commodity is coal, and coal rates were recently increased. Besides, coal is an important item in railway expenditure, and further increase in railway rates might lead to retaliation from the colliery proprietors, which might mean greater loss to the railway companies than the gain that would accrue to them from increased freight rates. Sea competition and inland navigation are facts which even an act of Parliament cannot nullify.

OBITUARY.

H.H. The Maharaja of Cooch Behar, G.C.I.E., C.B.—Colonel His Highness Sir Nripendra Narayan Bhup Bahadur, Maharaja of Cooch Behar, died on the 18th inst. at Bexhill. His Highness came to England for the Coronation, but illness prevented the carrying out of his intention to return to India at the end of the present month. The Maharaja was elected a member of the Society in 1901, and his loss is to be regretted as that of an eminent representative of the ruling chiefs of India. He bore a high reputation as an administrator, a reformer, and a sportsman, and was extremely popular both in his native country and in England. His character and services were fully appreciated by the three Sovereigns under whose reigns he lived. He was made a G.C.I.E. and a C.B. by Queen Victoria, and was an Honorary A.D.C. both to King Edward and to King George.

The Maharaja was born in 1862, and, as his father died before he was a year old, he had a very long minority, during which his territories were administered by the Government. Since his coming of age, he introduced many reforms and improvements in the State under his government, and he also served in the North-West Frontier Campaigns of 1897. He was a frequent visitor to England, and had many friends in this country.

GENERAL NOTES.

Whisky Age Certificates.—Since January 1st, 1908, Australian producers have had to bond their spirits for the statutory period of two years, the Spirits Act of 1906 having come into force at that date. They have now induced the Commonwealth Government to enact that, as from January 1st next, all imported spirits (other than gin, Genevan hollands, schnapps, and liqueurs) shall have been stored in wood for not less than two years, and they must be accompanied by an official Excise certificate to the effect that they have been so stored. In the absence of this certificate storage in Australia will be necessary. Nearly all the whisky shipped to Australia is more than two years old, but the Scotch Whisky Exporters' Association, and other trade bodies, are making strong representations to the Government, being fearful that owing to the shortness of the interval before the new regulation comes into force their interests will be seriously prejudiced. Australia is one of the principal export markets for Scotch whisky, so that the matter is one of importance to the trade.

Highest Electric Line in Italy.—The highest altitude yet reached by any line worked by electricity in Italy is that of the tramway from Biella to Oropa, the culminating point of which is 1,150 metres (3,735 feet) above the sea level. Oropa, which is situated among the mountains to the north-west of Biella, is much frequented during the summer on account of its pilgrimage church and hydropathic establishment. The line is about 14 kilometres (nearly nine miles) in length, and can carry upwards of 2,000 passengers per day.

THE MANUFACTURE OF BRANDY IN GERMANY.—The *Deutsche Wein Zeitung*, in a recent article entitled "Die deutsche Cognacindustrie," appears to ignore the fact that "Cognac" being the name of a French town, any brandy with that title made in Germany cannot be the genuine article. It gives some interesting statistics relating to the manufacture of brandy in that country. During the financial year 1908-9 the total number of brandy distilleries throughout the empire were 173, producing 11,348 hectolitres (249,546 gallons) of that spirit. In 1909-10 the number of factories and amount of production were as follows:—

	Distilleries.	Hectolitres.	Gallons.
Prussia	106	7,944	174,768
Bavaria	24	3,661	80,542
Hesse	16	854	18,788
Baden	10	342	7,524
Other Provinces	13	813	17,886
	169	13,614	299,508

The quantity of raw material (wine, etc.) dealt with in these establishments annually since 1900 was the following:—

Financial Year.	Hectolitres.	Gallons.
1900-1	38,655	850,410
1901-2	38,829	854,238
1902-3	24,286	534,292
1903-4	20,996	461,912
1904-5	32,990	725,780
1905-6	27,564	606,408
1906-7	30,963	681,186
1907-8	29,453	647,966
1908-9	63,366	1,394,052
1909-10	71,417	1,571,174

From this it will be seen that the immediate effect of increasing the duty on French cognac in 1909, from 160 marks to 225 marks per hectolitre (7*s*. 3*d*. to 10*s*. 3*d*. per gallon), was nearly to double the production of brandy in Germany. On the other hand, the increase of duty caused a loss to the revenue of upwards of 4,800,000 marks (£240,000).

SNAKES AND WILD ANIMALS IN INDIA.—The number of lives lost in India from snake bites, instead of diminishing, shows a lamentable tendency to rise. According to a statement published by the Home Department of the Government of India, the total of deaths from this cause in 1910 was 22,478, an increase of 1,114 over the figure for 1909, and of 2,740 over that of 1908. The increase in Eastern Bengal and Assam is attributed to snakes being driven by high floods to take refuge in the raised village sites. Both in this province and in the United Provinces a considerable number of cases were treated with the Brunton lancet and permanganate of potash, and a high proportion of them are reported to have recovered. No reliable deduction can, however, be drawn from the use of this lancet, owing to the lack of proof that the bites it was used upon were really those of poisonous snakes. The number of persons killed by wild animals last year was 2,400, compared with 2,496 in 1909; 55 were killed by elephants, 853 by tigers, 351 by leopards, 109 by bears, 319 by wolves, 25 by hyaenas, and 688 by "other animals." Some idea of the damage done by wild animals may be gathered from the fact that no fewer than 93,074 cattle were destroyed by them in 1910. The figures upon the other side of the account are also striking. The number of wild animals killed in 1910 was as follows: elephants, 23; tigers, 1,421; leopards, 5,029; bears, 2,292; wolves, 3,114; hyaenas, 414; other animals, 6,989; snakes, 91,104.

SYNTHETIC RUBBER.—A patent for manufacturing a substitute for indiarubber from the Soya bean has lately been taken out in Germany. The process consists in reducing the oil of this bean to the consistency of a thick paste by treating it with nitric acid. The paste, after repeated washings in some alkaline solution, is then heated to a temperature of 150° C. (402° F.). The product thus obtained is said to be quite homogeneous and elastic, and resembles indiarubber. It can also be vulcanized.

NUMBER OF NEWSPAPERS AND PERIODICALS IN FRANCE.—In 1640 only one newspaper was published in France, and it was not until 140 years later, namely in 1780, that the number was increased to twenty-four. In 1790, a time of political unrest, no fewer than 350 were published; in 1826, 490; and in 1874, 2,024. At the present time the total number of newspapers published exceeds 8,000. With respect to periodicals, France at the present time, heads the list with 8,940; Germany, 8,050; England, 4,329; Italy, 3,068; Belgium, 2,029; Russia, 1,661; Holland, 1,402; Spain, 1,350; and Switzerland, 1,322.

POPULATION OF GERMAN CITIES. — Advance figures compiled from the 1910 Census returns show that there are now in the German Empire forty-seven cities of more than 100,000 inhabitants. Of these seven have more than 500,000. They are Berlin (without suburbs), 2,064,153; Hamburg, 936,000; Munich, 593,053; Leipzig, 585,743; Dresden, 546,882; Cologne, 511,042; and Breslau, 510,929. Four others have more than 300,000 inhabitants. They are Frankfort-on-the-Main, 414,406; Düsseldorf, 356,733; Nuremberg, 332,539; and Charlottenburg (a suburb of Berlin), 304,280. Twelve other cities have over 200,000 inhabitants, and twenty-four others have populations ranging from 100,000 to 200,000 each. Ten years ago there were but two cities in the Empire with more than half a million inhabitants, and only thirty-three with more than 100,000. At the time of the first Imperial Census in 1871, there were in Germany only nine cities with a population exceeding 100,000. Berlin had reached the half million population in 1860, but Hamburg did not reach it until 1895, and no other German city before 1905. In 1871 Nuremberg had but 82,000 inhabitants; by 1900 it had increased to 261,081. The figures of the 1910 Census give it 332,539, an increase of about 27 per cent. during the ten years.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

COLONIAL SECTION.

LIST OF COMMITTEE.

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Lord Blyth (Chairman of the Committee).
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Sir John Wolfe-Barry, K.C.B., F.R.S.
Sir Frederick Young, K.C.M.G.
S. Digby, C.I.E. (Secretary).

"OWEN JONES" PRIZES FOR INDUSTRIAL DESIGN.

This competition was instituted in 1878 by the Council of the Royal Society of Arts, as trustees of the sum of £400, presented to them by the Committee of the Owen Jones Memorial Fund, being the balance of subscriptions to that fund, upon condition of their spending the interest thereof in prizes to "Students of the Schools of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, etc., regulated by the principles laid down by Owen Jones." The prizes are awarded annually on the Report of the Examiners in the National Competition of the Board of Education.

Six prizes were offered for competition in the present year, each prize consisting of a bound copy of "The Leading Principles in Composition of Ornament of Every Period," from the "Grammar of Ornament," by Owen Jones, and the Society's Bronze Medal.

The following is a list of the successful candidates:—

McCoy, Robert, School of Art, Macclesfield, for a Design for a Woven Tapestry Hanging.

Fildes, Berengaria, School of Art, Morecambe, for a Design for Printed Silk Dress Fabrics.

Dale, Sydney, School of Art, Macclesfield, for a Design for a Printed Velvet Hanging.

Hinton, Mabel L., School of Art, Dudley, for a Design for a Stencilled Hanging.

Meggs, Evelyn, School of Art, Dudley, for a Design for a Stencilled Hanging.

Fenske, May, Polytechnic School of Art, Battersea, for a Design for Printed Muslin.

The Examiners who judged the works submitted for competition report as follows:—

"587 works were sent in for this competition, showing an increase of 146 on last year, and the general level of merit is higher than then.

"The best examples are the Woven, Printed, and Stencilled Fabrics. There is a fairly good representation of the useful class of Damasks, as well as some good Carpets and Embroidery.

"The Examiners regret to find that no examples of Designs for Furniture have been submitted."

The next award will be made in 1912, when six prizes will be offered for competition.

THE ROYAL SOCIETY OF ARTS.*

By Sir Henry Trueman Wood, M.A.,
Secretary of the Society.

IV.—The Society and the Colonies.
(1754–1847.)

It is proposed in this article to deal with the efforts which, during the first century of its existence—from its foundation in 1754 to the grant of its Royal Charter in 1847—the Society made to encourage and develop the resources of the British colonies.

During that long period our colonial empire underwent many and great changes, both of restriction and of expansion. At its commencement "His Majesty's Colonies and Plantations abroad" meant, with some insignificant exceptions, only the North American colonies† and the West Indies. Before its close the American colonies had developed into the United States, Canada had become British, Australia had been partly explored and settled, the Cape and Ceylon had been taken from the Dutch, and many other additions, in many parts of the world, had been made to the British possessions. India also—for the earlier associations of the Society with India must be included in our review—had during this period definitely become a part of the Empire, which it assuredly was not in 1754.

It was in America, and before the Declaration of Independence, that during the first twenty years of its existence the most important part of the Society's work was done. The only reference that has been noticed in the Society's Minutes or *Transactions* about this time to the West African settlements, relates to the offer of a gold medal for the importation of cotton from Africa, and though the Society was ready to extend its efforts to the East Indies, and occasionally did so, its proposals do not appear to have been welcomed by the East India Company, which had distinctly monopolistic views as regarded its possessions. For example, in 1758 it was proposed that a prize should be offered for the production of cinnamon in "our own Territories in the Island of Sumatra," but the court of directors of the Company were "under apprehensions that if so valuable an article should be produced in the island, the Dutch will use their best endeavours to get possession of it." So the proposal was dropped, as was also a similar one for the encouragement of the production of cochineal.

At one of the first meetings of the Society after it had moved into its rooms in Craig's Court, in April 1755, Lord Romney informed the members that 300 lbs. weight of raw silk had lately been brought to England from Georgia, and that the silk was of very excellent quality, equal to the best Piedmont. He, therefore, suggested that the Society, by way of encouraging the production of silk in the colony, should offer a prize for planting mulberry trees, and it was thereupon resolved that a premium "of £10 sterling money" should be offered to the person "who shall plant, and properly fence, the greatest number of white mulberry trees on his own plantation in the province of Georgia before the first day of March 1756." Prizes of £5 and £3 were added for the second and third largest number. An announcement of this prize appears in the earliest list of premiums, dated April 1756, the date being extended to March 1757.

In 1758 the nature of the offer was modified, and a payment of threepence a pound was offered for cocoons raised in Georgia, and two shillings and sixpence a pound for merchantable raw silk produced in Connecticut, Pennsylvania or North Carolina, with another shilling per pound for silk imported into England. Franklin was interested in the development of the silk industry, and acted as one of the Society's referees for distributing the awards. Certain of the colonial governors also helped by their influence and interest. The British Government gave encouragement and a bounty, and a public

* The previous articles of the series appeared in the *Journals* of June 9th and 16th, and September 22nd.

† The original from which the map on p. 1033 is reproduced is contained in Jeffrey's American Atlas, London, 1776. It is in the possession of the Royal Geographical Society. The line following the course of the Mississippi is in colour, and indicates the western limit of the British possessions.

filature was established in Georgia. The offer of premiums was continued up to 1763, by which time a sum of over £1,100 had been expended. Although at one time the promoters of the scheme seem to have been sanguine about success, the industry was never established. The absence of cheap and abundant labour may have been one reason for this, but the outbreak of the War of Independence put an end to this attempt to nurse into existence what was really not a very suitable industry.

Much the same fate attended the efforts made to start wine-making in some of the colonies, though it, too, promised well for a time, and vineyards stocked from European sources were actually established in Virginia and elsewhere. The first offer of a prize for wine appears in the 1758 list, in which the amount of £100 is promised for five tuns of good wine made at a plantation in any colony, provided that one tun was imported to London. In 1763 Mr. Charles Carter sent a dozen bottles of two kinds of wine from grapes which grew in vineyards of his own planting in Virginia. One of these samples was the product of vines brought from Europe, and the other of American wild vines. The gold medal was awarded to Mr. Carter "as the first who had made a spirited attempt towards the accomplishment of their views respecting wine in America." * Amongst other awards for wine produced in the North American colonies, two hundred pounds were given to Mr. Edward Antill in 1768, for vines planted for making wine near Brunswick, North America; the Earl of Stirling † received a gold medal in 1769, for planting 2,100 sets for wine; and Mr. Christopher Sherb got fifty pounds in 1771, for planting and cultivating vines in South Carolina, and producing wine from them.

Much greater success attended the Society's efforts to encourage the production of potash and pearlash (a rather less impure form of potassium carbonate than the crude form of the salt then sold as potash). By the prizes offered, and still more by the information supplied as to the best means of manufacture, an important industry was set up, and one very suitable for a country abounding in forests. This prize was offered in 1758, the amount being £100 for fifty tons of potash.

* Dossie, "Memoirs of Agriculture, and other Oeconomical Arts," Vol. I. p. 242.

† This was William Alexander, "Commander-in-Chief of the American forces," who claimed and bore the title after the death of the 5th Earl in 1739. He was a member of the Society, and died in 1795.

There was a large and growing industrial demand for alkali, especially for use in glass-making, soap-making and dyeing. Until the great discovery by which carbonate of soda was manufactured from common salt, the foundation of modern chemical industry (it is interesting to note that the Society's premium list for 1783 includes an offer of a gold medal for the production of "Fixt Alkaline Salts" from common salt), this demand could only be supplied by alkali procured from the ashes of plants, and to a smaller extent by imported natural saltpetre. When such ashes are treated with water the salts of potash are dissolved, and on the evaporation of the solution they are recovered. Certain plants give much larger proportions of alkaline salts than others. Plants of the genus Salicornia, or glasswort (the Eastern name of which, "kali," was the origin of the term "alkali"), give the best material, and it was known as barilla. In England large amounts were obtained by burning kelp, and this was an important industry on the Scotch and Irish coasts. All plants, however, contain more or less potash, and therefore the raw material for the manufacture was abundant in America. There were some difficulties at first in the production and purification of the salts, but these were eventually overcome by the full and detailed instructions sent out by the Society to the colonial authorities at their request.

It is interesting to note that in 1766 Robert Dossie, the able and accomplished editor of what was practically the first series of the Society's *Transactions*, was presented with a gold medal for "effectually aiding to establish the manufacture of potash in North America."

The result of the attempt to encourage the production of saltpetre in America was less satisfactory. It seems that the prize was really offered (in 1764) in the hope that it might lead to the discovery of natural sources of supply of nitrate of potash or soda, though Dossie tells us that the Society was also encouraged by reports of some new method of manufacturing the salt having been discovered in America. The old system of obtaining nitre from "nitre-heaps," mixtures of animal excreta with wood-ashes and lime, was obviously not well suited for a sparsely populated country like America, and it was not to be expected that there would be any artificial nitre produced in excess of the requirements for home consumption.

But the hope of discovering natural sources

of supply of natron,* the neutral carbonate of soda ($Na_2CO_3$10 Aq.), was perfectly reasonable. The salt existed in various forms, sometimes as an efflorescence on ground or rocks, sometimes in mineral springs or lakes, and sometimes as solid deposits in "pits" in many countries. The "soda lakes" in the Libyan desert and in Upper Egypt were known from remote antiquity. Herodotus (ii. 86) describes the use of the nitron obtained from them in embalming. The natron pits of Khaipur in Sind have long been a source of revenue to their owners, and there were numerous other places in the Old World whence the material was brought to England before the secret of making "artificial saltpetre" was purchased from the German Honrick by Queen Elizabeth. There was, therefore, every reason to believe that similar deposits might be found in the New World. Indeed, in our own days, the anticipations of the Society have been justified by the discovery of the vast nitrate fields of Chile, from which nearly all the world's supplies of nitrate of soda are now derived.

However, the hopes were not realised, and as no response was made to the offer it was withdrawn after a few years, though at a later date it was renewed, and in 1786 a silver medal was actually awarded to H. Scott, a surgeon in the East India Company's service in Bombay, for a sample of "native Indian fossil alkali." This was "a brown earth brought from Sindy." It was stated that large amounts of the earth were available, and on analysis it proved very rich in alkali. Very probably this was the first introduction to England of soda carbonate from the natron pits of Sind above mentioned, though it may indeed have been imported without its source of origin being known.

The only connection between the Society and the manufacture of iron in America seems to have been that a prize was offered for making iron from "black sand" (magnetic oxide of iron). The offer was a reasonable one, but the solution of the problem was far beyond the metallurgical knowledge of the time, and indeed, until lately, it has never been possible to treat this ore successfully. Still a certain amount of success was attained, for a gold medal was given in 1763 to Jared Eliott for malleable iron from American black sand. According to Scrivenor,* iron was first made in America in 1715, and the amount made steadily increased, until about 1776 some 4,000 tons were exported. Ten years later the amount produced in England and Wales was only 13,000 tons, the production having fallen off in consequence of the diminished supply of wood, the only fuel by which iron could be made.

With its enormous forests, America might well have supplied the English market for iron, and from time to time provisions were grudgingly introduced into Acts of Parliament with the view of encouraging the industry, but when any encouragement was given it was either so set round with limitations as to be useless, or was soon taken away at the appeal of the English iron-makers, in spite of the demands urged by those who wanted iron but were not makers. An account of the legislation from 1719 to 1769 is given by Scrivenor, and it is as little creditable to the British Government as were most of the dealings of this country with its American colonies.

The Colonial Manufactures Prohibition Act, 1750, so far encouraged the production of raw iron that it removed the duties on bar or pig iron, but it not only forbade the working up of such iron, but prohibited the establishment in America of furnaces, tilt-hammers, or slitting-mills for the purpose. England at this time was always ready to help the colonies, provided only they did not compete with her own manufacturers. Raw materials to any extent they were encouraged to provide, but manufactured articles of any sort they were not permitted to export, or even, in most cases, to produce.

A considerable amount of hemp has always been grown in England, but large quantities were imported from abroad, especially from the Baltic ports. It was thought that the North American colonies might become sources of supply, and a prize was therefore offered for American imported hemp. Soon, however, it was realised that, as there was a great local demand for hemp for rope-making, and the price was consequently higher in America than in England, it was not likely that the fibre would be sent over here, and the conditions of the offer were changed, so that it might serve to encourage the actual production of the fibre

* The word natron, never common, is now practically obsolete, though Murray's Dictionary gives an authority as late as 1876. It is, perhaps, derived from the Arabic natrūn, the Greek equivalent being νίτρον, the Latin nitrum. Our own nitre is now only used as the equivalent of saltpetre (potassium carbonate), but it was originally employed as identical with natron. Skeat suggests that the sense of the word has been changed, but it is probable that it is merely a case of a word originally used in a general sense, having its application reduced, as chemical technology became more accurate, to a specific substance.

* "History of the Iron Trade" (1854), p. 69.

without calling for its export. The scarcity of labour, however, again proved an obstacle, and though some hemp was grown, there were difficulties in obtaining labour to treat the stalks for the production of the fibre.

As regards one important application of hemp at the time, the manufacture of sail-cloth, it soon found a rival in the native American fibre, cotton, which was extensively applied to sail-making in America, before its use was ever adopted for the purpose on this side of the Atlantic. Later on, as will be seen, when

Canada became a British possession, the cultivation of hemp in that country was successfully established by the Society's efforts.

The Society expended a good deal of money in the attempt to organise a supply of pickled sturgeon from the North American colonies. It appears that there was a considerable import of this fish from Russia, and that which was brought over from the colonies was nearly as good. The attempt seems to have been moderately successful, but the demand was not very large, and no doubt the trade was a small one. The premium was first offered in 1760, and was continued for some time, various sums of £50 and less having been paid for importations on a commercial scale of the preserved fish.

The offer, made in 1768, of a reward for American isinglass, might seem more likely to have had good results, but it was dropped on an appeal from the owner of a patent* for making isinglass in England, who hoped to obtain abundant material for the manufacture from the Newfoundland cod fisheries. Dossie† tells us that these hopes were not realised, though the Society was led to abandon its offer.

The sturgeon of the American Great Lakes and rivers (*Acipenser rubicundus*) is a different species from the Russian sturgeon (*A. stellatus*), and is less abundant. Economically, however, it is equally valuable, and is now the subject of a considerable industry. The flesh is pickled, while caviar and oil are also made from the fish. The offer, therefore, of the Society, though fruitless at the time, was reasonable enough, for it only anticipated by a century or so the establishment of an important industry.

Another object on which a good deal of trouble and some money was spent, was an attempt to import myrtle wax, or, as it is now commonly called, myrtleberry wax, from North America. This is a well-known vegetable wax, the produce of *Myrica cerifera* and other species of *Myrica*, which are found in North and South America, Africa, and elsewhere. The plant is not a myrtle at all, but is allied to the willow tribe.‡ The British representative of the genus is *Myrica gale*, gale, or Scotch or Dutch myrtle, also "bayberry tallow," common in moist heathy grounds. A kind of wax can be obtained from this plant when it is boiled. Some foreign species supply wax in greater abundance, the succulent fruit being covered with a waxy secretion. The product of the American species, known as bay myrtle, or candleberry bush, had long been used, in combination with beeswax, for the manufacture of wax candles, and at the time, when there was a great demand for materials for candle-making, it was thought that the importation of such a material would be valuable, if on a sufficiently large scale. Accordingly, a prize of £20 was offered in 1759 for the importation of the material in commercial quantities. Prizes were awarded in 1760, but after that they were dropped, as it was not considered that a sufficient amount of the wax was likely to be imported; in fact, as Dossie said, the only application of the material was the "sophistication of plasters in the manufacture of them by some wholesale dealers in medicinal preparations."

In 1776 an application was made to the Society by certain coopers to give assistance in promoting the importation of pipe staves from America in place of those brought from Germany. The committee which was appointed to consider this matter found that at least £100,000 was annually paid for staves imported from Germany, and that Quebec oak made into staves would answer all the purposes of the German; but whether any practical result came of the suggestion does not appear to be known.

Such were the more important or interesting colonial products, the growth or importation of which the Society strove to promote. Amongst others of minor value may be mentioned olives, raisins, logwood, cochineal, scammony, opium, safflower, persimmon, aloes, and sarsaparilla.

Besides encouraging the production of new commodities in the colonies, the Society rendered valuable service on occasion by sending out machinery. As will be mentioned in a future article, the Society succeeded in establishing a saw-mill in England, and the result of this was an inquiry from America, where there would be much greater scope for the use of such machinery.

Accordingly, the Society paid Stansfield, the original constructor (he cannot well be called the inventor, for the machinery had long been in use in Holland and Germany), £60 for a model of his apparatus, and sent it out to America. It appears to have been useful, for

* An examination of the lists of patent grants about this date has not afforded any clue to this patent.

† Vol. I. p. 276.

‡ The myrica of Virgil (and Pliny) is not the same plant at all, but a tamarisk. When in his Eclogues (viii. 54) Virgil includes in his list of portents the production of amber by the tamarisk—

"Pinguia corticibus sudent electra myricæ,"

he was perhaps influenced by the knowledge that the tamarisk really does produce a secretion, so-called manna, the result of the action of a coccus inhabiting the tree. Hence the botanical name of one species, *Tamarix mannifera*.

"the good effects of it have been acknowledged in the strongest terms by the governor of one of the colonies and some other principal persons."* As Dossie remarks that from this model the colonists were able to make great improvements in their saw-mills, it is evident that such mills were in use in America before they had been established in England.

A gold medal was awarded in 1766 to Sam Brown, of Georgia, "For his useful observations in China, and industrious application of them in Georgia." No record has yet been found of these observations, so it is not known what they were.

The Declaration of Independence in 1774, and the resulting separation of the United States from the Mother Country, of course put an end to the attempts of the Society to develop the resources of the North American colonies, and from that date till the end of the century the attention of the Society was practically confined to the West Indies. Here a considerable amount of useful work was done. Sometimes the offer of prizes produced immediate practical results, sometimes the suggestions originated experiments and inquiry, so that ultimately useful industries were started, and valuable imports obtained.

Among the vegetable products, for the growth of which in the West Indies prizes were specially offered, may be mentioned mango, bread-fruit, olive, opium, cinnamon, nutmegs, sarsaparilla, aloe, safflower, indigo, cotton, anatto, vanilla, cloves, pepper, mace, camphor, quinine, various tinctorial plants, and ornamental woods. For several of these rewards were claimed and awarded, but in other cases the offers produced no practical result.

The main idea which directed the efforts of those who were trying to develop the West Indies was the introduction into the new lands of the West the known and tested products of the ancient civilisation of the East. Those who in the eighteenth century were working with this object were only following the lead of the earliest colonisers of America. The Spaniards introduced the sugar-cane into San Domingo before the end of the fifteenth century, and it flourished as it had never done in the Eastern lands where it was indigenous. Coffee was introduced by the French into either Cayenne or Martinique about 1722, and it soon spread to the other islands.† By 1770 or thereabouts it was a staple product of Jamaica. The Oriental bamboo is believed to have been artificially planted in Hispaniola, whence it spread to Jamaica and the other islands. Cotton was indigenous in the Western Hemisphere, though the species was different from the cotton of the East known to Herodotus, Theophrastus and Pliny, the wild tree bearing fleeces from which the Indians made cloth. The cotton grown in the islands was no doubt brought from the mainland. The orange is believed to have been introduced by the Spaniards into the West Indies, and to have been transplanted thence to Florida. Long, in his "History of Jamaica" (1774), speaks of it as growing wild in that island, but not being properly cultivated, as it was in South Carolina. The mango is said to have been first introduced from the East Indies into Brazil by the Portuguese, and to have been transplanted thence to the islands; of which more hereafter.

In continuation of these importations, the English colonists and their associates at home hoped to transplant to the tropical western islands the economic flora of India and the spice islands, especially the latter, while they were also not unmindful of the resources placed at their disposal by the recent discovery of the islands of the South Seas.

The first mention of the West Indies occurs in the Premium List for 1759, which contains a special offer of £100 for cochineal from Jamaica, though in the previous lists various prizes were included which were open to the West Indian in common with the other colonies.

The story of the introduction of the bread-fruit (*Arto-carpus incisus*), with its incidents of the mutiny of the "Bounty" in 1789, the abandonment of Captain Bligh, and the colonisation of Pitcairn Island by the mutineers, is well known.

The first suggestion that the bread-fruit might be introduced into the West Indies is said* to have come from Valentine Morris, the Captain-General of St. Vincent, who wrote in 1772 on the subject to Sir Joseph Banks, and no doubt as the result of this letter a prize was offered in 1777 by the Society. In 1786 Sir Joseph, urged by Mr. Hinton East, of Kingston, Jamaica, who was then in London, brought the matter before George III., and the result was that the expedition of which

* Dossie, Vol. I. p. 126.

† In a little "History of Coffee," by W. Law, of Edinburgh, "coffee merchant to the Queen" (1850), it is stated that the coffee plant was introduced by the French into Cayenne from Surinam in 1722, and five years later into Martinique. According to another account it was sent to Martinique direct from France, a coffee tree having been presented to Louis XIV. by the magistrates of Amsterdam.

* E. Smith, "Life of Sir Joseph Banks" (1911), p. 123.

Captain Bligh was the commander, was sent to the South Seas in the "Bounty" to collect bread-fruit trees and to transport them to the West Indies. The fullest instructions were drawn up by Banks, the ship reached Otaheite, and a number of plants were collected. All went well until the return voyage from Otaheite, when the mutiny took place, and Bligh was sent adrift in the ship's launch. A second expedition was more successful, and in 1793 a cargo of bread-fruit trees was safely conveyed to the West Indies by Captain Bligh in H.M.S. "Providence." On his return, Captain Bligh sent in a full report to the Society,* from which it appeared that over 300 bread-fruit plants had been successfully landed in Jamaica, and a like number in St. Vincent, besides a large number of other plants from the Pacific Islands. Most of these are only described by their native names, but the list includes mango, pomegranate, cocoa-nut, coffee, almond and plaintain. The gold medal was, on this report, awarded to Captain Bligh.

From reports made to the Society in 1795 by General Melville, and by Dr. Dancer in 1796,† it appears that the trees grew and flourished in the islands, and a little later similar information was received from St. Vincent. Dr. Alexander Anderson, the Superintendent of the Botanic Gardens in that island, reported fully in 1798 on the condition of the trees there, and stated that they were well established and were producing an ample supply of the fruit.‡ Later reports in 1802 and 1803 were equally satisfactory, and in 1807 he writes that though it is one of the most valuable productions sent to the West Indies, it is not appreciated at its proper value. He adds that it is said that the negroes did not like it, but that he did not believe this. Its want of popularity he attributes to the apathy of the planters. It may be added that in 1799 a gold medal was awarded to S. Mure for a plantation of bread-fruit trees in Jamaica, and two gold medals were given in 1802 and in 1803 to the Hon. Joseph Robley, the Governor of Tobago, for his plantation of bread-fruit trees in that island.

In 1760 a gold medal was offered for the introduction of the mango into the West Indies, but after three years the offer was dropped. Twenty years after this, in 1784, Walter Maynard, of Nevis, wrote to the Society that in 1770 he had brought some young mango plants from the Island of Bourbon to St. Vincent, that they had fruited there, "and are now propagated in almost all the West India islands." The statement was supported by evidence, and it was said that one of the plants had been given to Dr. Young, the Superintendent of the Botanic Gardens at St. Vincent.* It appeared, however, that this was not the first introduction of the mango, for on inquiry being made of Mr. Joshua Steele, a member of the Society, and the President of the Barbados Society of Arts, that gentleman sent the Secretary an account of an ancient mango tree then existing in a plantation in Barbados, called "The Guinea."† This tree had, it was believed, been imported and planted by Edwin Lascelles in 1742 or 1743, but it bore no fruit till 1761. It is very likely that this was the tree mentioned by Dossie‡ as having been brought from the Brazils, where the mango was said to have been introduced from the East Indies by the Portuguese missionaries. From this tree others had been propagated, and were growing in different parts of the island. It is clear, therefore, that the mango was well established in the West Indies in 1784. It has been said that Lord Rodney introduced the fruit in 1782, but this cannot be true. One of Lord Rodney's captains (Captain Marshall, of the "Flora" frigate) certainly captured a French ship, carrying some economic plants from Bourbon to Hispaniola, and these plants were sent to Jamaica. It is quite likely that mangoes may have been included in the cargo. It is also possible, and by no means unlikely, that the French may have introduced the mango into Martinique, with other plants they sent there, before it was established in any of the British islands.

Among the plants whose destination was thus altered, were some young cinnamon trees, and this appears to have been the first introduction of the Eastern cinnamon to Jamaica, for which the Society had offered a prize as far back as 1760, though the Guadaloup cinnamon is mentioned by Dr. Young. Dr. Dancer, the Superintendent of the Jamaica Botanic Gardens, writing in 1789 to the Society, gives an account of the condition of the cinnamon trees then growing in the island, and describes them as flourishing, but not very numerous.§

* *Transactions*, Vol. XIII. p. 305.

† *Ibid.*, Vol. XIII. p. xviii., and Vol. XIV. p. xv.

‡ *Ibid.*, Vol. XVI. pp. xii. and 327.

* In his report on the Botanic Gardens, referred to on page 1037, Young mentions the "East India mangoe" as having been introduced into St. Vincent. This was in 1773.

† *Transactions*, Vol. IV. p. 219.

‡ Vol. I. p. 286.

§ *Transactions*, Vol. VIII. pp. viii. and 207. See also Vol. IV. p. 22).

Indigo was at one time largely cultivated in Jamaica, but heavy import duties imposed by Parliament* destroyed the industry, the revival of which seems to have been stimulated by the Society, not only in Jamaica, but in the other islands; for in 1778 a gold medal was awarded to John Robley for growing and manufacturing indigo in Tobago. The account given in the *Transactions* † states that in one year as much as 10,000 lbs. of good indigo was raised on a plantation formerly devoted to sugar-planting. The indigo was presumably the indigenous Mexican and Guatemalan variety, *I. disperma*, not the East Indian sort, *I. tinctoria*. Four years previously, in 1774, a gold medal had been awarded for the production of indigo in East Florida.

A gold medal was offered in 1768, and the offer was continued till 1777, for the best specimen of cotton equal to "the best Brazilian," produced in any of the American colonies, but it appears not to have attracted any claimants till 1778, when it was awarded to Andrew Bennet, of Tobago, for cotton grown in that island.

A prize offered for logwood from British colonies was abandoned, because it was found that the wood produced in Jamaica was inferior to native Honduras and Campeachy logwood, and besides that the cultivation of logwood in the sugar islands was unnecessary and undesirable, since it became practically a troublesome weed.

A great deal of valuable work was done in the West Indies by the establishment of botanic gardens, and they were aided in various ways by the Society. In one of the earliest Premium Lists, that for 1760, it is suggested that land should be allotted in the colonies for "gardens or nurseries for the making experiments in raising such rare and useful plants as are not the spontaneous growth of the kingdom or of the said colonies," and it is added that if the colonial legislatures, or "other incorporate bodies," would help to establish such gardens, the Society would provide "proper premiums" for plants raised in them. This undertaking was liberally and fully carried out. The suggestion soon bore fruit. The first of these gardens was started in St. Vincent in 1765 by General Melville, the Governor-General of the "Southern Caribbee," or Windward Islands, a member of the Society, whose attention was attracted by the notice.‡

* Long, "History of Jamaica," Vol. III. p. 680.

† Vol. II. p. 233.

‡ Dossie, Vol. III. p. 196.

Dr. George Young, an army surgeon in the island, took charge of the gardens. He was acting as superintendent of them in 1774, and in that year sent the Society a full report* on the gardens, for which he received a gold medal. For a time the island was in possession of the French, but the garden was kept up. In 1784 St. Vincent was restored to Great Britain, and Dr. Alexander Anderson took charge of the garden. In 1798 he received a silver medal from the Society for an account of the plants cultivated in it, and in 1802 he was awarded a gold medal for the "culture of cloves and cinnamon." He was a corresponding member of the Society, and a constant contributor to the *Transactions*. He died in 1811.†

In 1775, according to a letter written by Dr. Hope (the Professor of Botany at Edinburgh) to Sir Joseph Banks,‡ a botanic garden was founded in Jamaica. Dr. Clarke was appointed superintendent, and he introduced the camphor-tree and sago palm.

Later, Dr. Dancer had charge of this garden. He received the Society's silver medal in 1790 for his account of the cinnamon tree in Jamaica above referred to. He was a valued corresponding member, and, like Anderson, a frequent contributor to the *Transactions*.

In the year 1793 the Society offered 100 guineas for the establishment of a botanic garden in the Bahamas. This offer was repeated annually up to 1802, but no response having been made, it was then withdrawn.

The Society does not seem to have had any association with the botanic garden in Trinidad, but in 1831 David Lockhart, "Botanical Gardener to the Government of Trinidad," received a gold medal for the successful culture of nutmegs and mace in that island.

In the case of the West Indies, as with the North American colonies, useful service was rendered by the transmission of seeds, samples, etc., the provision of machinery and models, and the supply of information.

A good deal of correspondence has been preserved in the old guard-books of the Society, showing the anxiety of the colonial officials and others to obtain such information, and the readiness of the Society to collect and supply it, and it appears quite certain that the aid thus rendered

* Dossie, Vol. III. p. 260.

† In 1825 the Rev. Lansdown Guilding published at Glasgow an account of the St. Vincent Garden from its establishment to 1825. The book contains a good deal of information about Anderson and his work. A copy is in the Society's library.

‡ E. Smith, "Life of Sir Joseph Banks" (1911), p. 122.

was fully appreciated. That the Society was so successful in this branch of its work was due to the fact that it was in constant communication with the officials on the spot, and with those colonial residents who took an interest in the economic progress of the islands, and could supply information as to local requirements. On the other hand, it had the command of the best advice from scientific men at home who could provide the requisite botanical and chemical knowledge (so far as such knowledge existed at the time), and from manufacturers and traders who knew what products would best find a market in Europe. The staple products of the islands were not considered to need encouragement or help, and so we read little in the Society's colonial records about sugar or tobacco. The object was to discover new sources of revenue, to introduce fresh industries and new economic plants, and there is no great reason for surprise if we find that many of the suggestions bore little or no fruit. On the whole, the efforts of the Society to aid colonial progress during the first fifty years or so of its existence were well applied, and had very considerable practical results.*

In the early years of the new century the interest which had been taken in the West Indies, so far as relates to the introduction of new economic plants, grew less. This may have been partly due to the death of those men in the islands who had devoted themselves to the work; for when Young, Dancer and Anderson had all passed away, the Society lost its most important correspondents, and there were none to take their place. But beyond much doubt the real cause was the dislike of the planters to anything which interfered with the cultivation of the sugar-cane. Sugar was firmly established as the staple industry of the islands; it was successful and profitable, and the planters not only did not desire, but were inclined to oppose, the introduction of any other crop which might interfere with its cultivation. In one of the letters which Anderson wrote to the Society in 1807, he refers to this feeling. The result was that the efforts of those on this side who had tried to encourage the introduction of new economic plants were relaxed, and though the special offers of prizes for the growth of West Indian products remained in the Society's lists, the awards became fewer, though some were occasionally claimed. For instance, in 1824 a sum of fifty guineas was presented to Francis Le Cadre for his plantation of clove trees in Trinidad.

As before stated, the Society in its early years had but little connection with India and the East, though on occasion it was consulted by the East India Company, and information was supplied to it by the Company. A few, but not many, prizes were offered for the productions of the British possessions in the East Indies, and only a small proportion of these were claimed. The award of a gold medal in 1792 to George Unwin "for reviving the trade of tin from this country to India and China" was intended as an encouragement to British rather than to colonial or Indian industry, but it is curious, because it was after the importation of Eastern tin to Europe had begun. It was about 1787 that the first samples of tin from Banca, in Sumatra, were brought over, and a source of supply of the metal made known which soon interfered with the monopoly possessed by the Cornish mines. Before many more years the course of trade was in the other direction, and large amounts of tin were being brought from Banca to England. From 1800 to 1821 a prize was open for the importation of "Bhaugulpore cotton"—"from which clothes are made in imitation of nankeen, without dyeing" — but without any effect. This offer was at first confined to the "British Settlements in the East Indies," but it was afterwards extended to the other colonies. In 1792 a silver medal was presented to Mrs. Anstey, of Madras, for the introduction of cinnamon in 1781. In 1801 Andrew Stephens, of Calcutta, had a silver medal for "Lake from stick lack." The award of a prize for Sind natron in 1786 has been mentioned previously on page 1032. About the end of the century, however, a greater interest seems to have been aroused in Indian matters on the part of the Society, and perhaps the Company were more ready to avail themselves of such advantages in the way of technical advice and publicity as the Society was able to supply.

It is probable, too, that the new interest in East Indian matters was, to a large extent, due to Dr. William Roxburgh, the great Indian botanist, who was Superintendent of the Calcutta Botanic Gardens from 1793 to 1813. Roxburgh became a corresponding member of the Society

* From the account published in 1783 of the amounts awarded in premiums up to that date, it appears that £2,785 13*s*. 8*d*. had been expended, and fourteen gold medals awarded by the Society as rewards in the colonies. Of this amount, £175 was spent for importing earth nuts, myrtle wax, sturgeon, and zebra wood; £50 for making indigo, iron, and saltpetre; £1,666 for planting vines and mulberry trees, and producing silk and cotton; and £895 for the manufacture of potash and pearlash.

in 1797, and from that date until the time of his death in 1815 he was constantly forwarding communications, most of them of considerable interest and value, to the Society. In 1798 he sent the first specimen of Malayan rubber to the Society, having discovered the source of the rubber in the tree which he described and named *Ficus elastica*. Caoutchouc had been known since the middle of the eighteenth century, but only as a curiosity, and as useful for rubbing out pencil marks. Priestley in his book on "Perspective" (1770), refers to this use, and mentions that the price of a block half a cubic inch in size was three shillings. The sources of rubber in Para, and the method of collecting it, were well known; samples frequently reached Europe, and the gum was described to the Paris Academy of Sciences by La Condamine, who had been sent out by the French Government to measure an arc of the meridian near Quito. Its properties were afterwards investigated by Fresnau, who submitted a memoir on the subject to the French Academy in 1751. It may be added that at a later period rewards were offered by the Society for caoutchouc from Africa, the West Indies, and elsewhere, but without any result.

Roxburgh was also the first to introduce to Europe the important fibre ramie (now classified as *Boehmeria Nivea* var. *tenacissima*, but named by him *Urtica tenacissima*). He reports* that he had plants growing in 1804 in the Botanic Gardens, Calcutta, from Malay seed. Nine years later, in 1815, a silver medal was awarded to Captain Cotton, for growing ramie (which is termed "calooee hemp") in Bengal, apparently from plants or seed obtained from Sumatra by Dr. Roxburgh. Captain Cotton's communication to the Society is probably the first account of the plant and its treatment.† From that date up to the present the development of ramie has formed a constant topic of discussion at the Society of Arts. In 1860 Dr. Forbes Watson prophesied that the fibre from this and other plants of the nettle species would occupy a place second only to that of flax. Dr. Watson's prophecy has perhaps not yet been quite realised, but it is certainly on the way to realisation, as the various difficulties of manufacture are being overcome.

Various other communications were made by Dr. Roxburgh to the Society, but none of them have quite the same present interest as the two above referred to. He received a gold medal in 1805, and another in 1814, for his communications on East Indian products, and on many other occasions he was formally thanked by the Society for the valuable information he supplied to its *Transactions*. A portrait of Dr. Roxburgh forms the frontispiece to Vol. XXXIII. of the *Transactions*, and the same volume contains a memoir of him.

* *Transactions*, Vol. XXIV. p. 148.

† *Ibid.*, Vol. XXXIII. p. 182.

In the year 1843 Dr. William Montgomerie, of Singapore, sent to the Society some samples of gutta-percha, and in the same year Dr. José D'Almeida presented some specimens to the Royal Asiatic Society. Nothing was done with D'Almeida's specimens, but those of Montgomerie were examined by the Joint Committee of Chemistry, Colonies, and Trade, which resolved "that this substance appears to be a very valuable article, and might be employed with great advantage in many of the arts and manufactures of the country." This resolution was passed at a meeting on January 23rd, 1845. At the ordinary weekly meeting on March 19th, the Secretary, Mr. Francis Whishaw, described the specimens and showed a piece of pipe and a lathe-band made by him, which were afterwards exhibited at the Great Exhibition of 1851. He also produced some good impressions of medals. It was at this meeting that Sir William Siemens became acquainted with the new material, and obtained a sample, which was subsequently sent to his brother Werner in Berlin, to try whether it was suitable for insulating telegraph wires. In June of the same year the gold medal was awarded to Dr. Montgomerie for his discovery. He had previously (in 1842) received a gold medal from the Society for the cultivation of nutmegs in Singapore.

Nothing was said or apparently known about D'Almeida, on whose behalf a claim was made many years later, in 1858, by his son, whose letter will be found in the *Journal*.* Such evidence as there is appears to show that in point of time Montgomerie was the first to realise the value of the gum, because in March 1843 he had already submitted samples of gutta-percha to the Bengal Medical Board before sending the samples to London. But whichever of the two claimants may have been first to suggest the practical value of gutta-percha, there is no doubt that it was Montgomerie's action which first introduced it to public knowledge, and rendered its practical applications available.

The subject has been very thoroughly worked

* Vol. VII. p. 20.

out by the late Dr. Eugene Obach in his Cantor Lectures on "Gutta-percha." Many further details will be found in the report of his first lecture,* and there is much other information about the early history in the appendixes which were added by Dr. Obach when the lectures were republished.

As far back as 1788 Sir Joseph Banks suggested to the court of directors of the East India Company the practicability of cultivating the tea plant in British India; but nothing came of the suggestion, probably because the H.E.I.C. then had the monopoly of the China tea trade, and saw no advantage in starting a competition. In the year 1822 a gold medal was offered by the Society to the person who should communicate, from information obtained in China, the best and most authentic account of the culture of the plant or plants, the leaves of which furnish the different kinds of tea, together with the method of gathering, drying and otherwise preparing the leaves. This offer was supplemented in the following year by one of the gold medal or fifty guineas to the person who should grow and prepare the greatest quantity of China tea of good quality, not being less than 20 lbs. weight, in the island of Jamaica, or in any other British West Indian colony, and should import the same into Great Britain. The same premium was offered for the colonies of the Cape of Good Hope, Mauritius, and New South Wales. These offers, opportune as they certainly were, seem to have been in advance of their time, for they produced no response. Twelve years later, in 1834, when the East India Company's monopoly had expired, and there was no longer any objection to a rival to the China trade, it was realised that it was not safe or desirable that England should be dependent on China for its supplies of tea, and steps were taken to ascertain the possibilities of raising tea in India. A committee was appointed by the Governor-General, Lord William Bentinck, with Dr. N. Wallich, the successor to Dr. Roxburgh as Superintendent of the Calcutta Botanic Gardens, as its secretary. The existence of wild tea in Assam had been discovered "perhaps originally by Major Bruce, subsequently in Manipur by Mr. Scott" (Watt) between 1821 and 1826, but no attention had been paid to the discovery, and China plants were imported. In the meantime the Assam tea tree had been rediscovered by Captain Charlton and Captain Jenkins. The general belief is that the introduction of the Chinese plant was a mistake, and that the hybrids which were produced were inferior to the native Indian shrub. Eventually tea plantations were established in Assam, and in 1836 Mr. C. A. Bruce was appointed superintendent. Samples of the tea were sent to England in 1838, and were presented by the H.E.I.C. to the Society. In 1839 a Committee of the House of Commons on the subject reported favourably on Mr. Bruce's work, and in consequence of this the gold medal offered seventeen years before was awarded to him in the session 1839–40, "for his meritorious services in discovering the indigenous tea tracts and cultivating and preparing tea in Assam." There seems no doubt that Mr. Bruce's work was well deserving recognition, but it seems equally certain that he was in no sense the discoverer of the tea plant or "the indigenous tea tracts."*

In 1831 Dr. Wallich, the Superintendent of the Calcutta Botanic Gardens, presented through the court of directors of the East India Company, a very fine collection of Indian woods, containing 456 specimens,† and for this in the following year he was presented with a gold medal. Dr. Wallich, who was a corresponding member of the Society, had previously sent some valuable communications on Indian economic plants, which appeared in the Society's *Transactions*. In 1834 another collection of Indian and other woods (comprising 452 specimens) was presented by Captain H. C. Baker, of the Bengal Artillery.‡

Ceylon was not a British colony till 1802, when it was ceded to Great Britain by the Treaty of Amiens. It seems to have received but a small share of the Society's attention. In 1815 a silver medal was awarded to Thomas Hoblyn for the introduction of cocoa-nut oil from the island, and in the following year he received a gold medal for inventing and introducing into Ceylon a machine for decorticating rice. This machine, as well as a press for the production of the oil, is described in the *Transactions*.§ The decorticating machine appears to be the first of its kind, at least the earliest patent for such apparatus is dated 1819; it anticipates in many of its details the principles on which later

* *Journal*, Vol. XLVI. p. 98.

* Watt, "Commercial Products of India," s.v. *Camellia Thea*; Berry White, "Indian Tea Industry," *Journal*, Vol. XXXV. p.734; *Transactions*, Vol. LII. p. 200; Vol. LIII. p. 30.

† A catalogue is printed in the *Transactions*, Vol. XLVIII. p. 441.

‡ *Transactions*, Vol. I. Part II. p. 173.

§ *Ibid.*, Vol. XXXIII. p. 60; Vol. XXXIV. p. 250. The press was constructed by Bramah, and the decorticating apparatus by Maudsley.

machines for the purpose were based, especially the application of adjustable mill-stones for husking the rice. Before this invention the operation was carried out with a pestle and mortar, the result being that the grains were, to a large extent, broken and rendered useless.

For Canada, it cannot be said that very much was done by the Society. When the Society began its colonial work, Canada was still French; it was only partly explored and quite undeveloped, and for some time after it passed under the British flag there were few industries of value, except the exportation of furs. Yet, as time went on, and the country was settled, the Society endeavoured to do its duty to what was then the greatest colony, or group of colonies, belonging to Great Britain, and much of interest about Canada is to be found in the *Transactions*. In the early part of the nineteenth century a strong effort was made, and with a good deal of success, to encourage the growth of hemp, a fibre then in great demand for naval purposes, as it was practically the only material available, not only for ropes, but also for sails. In 1801 various medals and prizes were offered for the growth of hemp in the two Canadas, Nova Scotia and New Brunswick, and these were continued for thirty years. Many of these were awarded. In 1804 a gold medal was awarded to J. W. Clarke, a similar medal and 100 guineas to Jacob Schneider, and a silver medal to Daniel Mosher. In 1806 silver medals were awarded to Philemon Wright, Frederick Arnold and Joshua Cornwall, also a prize of twenty dollars to G. Ward. In 1809 a silver medal "set in a broad gold border" was given to C. F. Grece, and a silver medal to Mr. Durand. All the above were Canadians. It is stated in the *Transactions* that, as a result of the attention which had been drawn to the subject by the Society's announcements, a considerable trade in hemp had been set up, and a large amount of fibre imported.

The offer of a prize for the growth of hemp was a little later extended to the other colonies, and there was added a reward for the discovery of a good substitute. In announcing this award in 1823 a note was added, drawing special attention to the *Phormium tenax*, or New Zealand flax, of which specimens had lately been brought to England. The importation of the fibre rapidly extended, and between 1828 and 1832 no less than £50,000 worth was shipped to Sydney alone.* The present annual value of the export from New Zealand is £307,000.

It does not appear what prompted the offer in 1792 of a gold medal for the discovery of a "North-West Passage by land from Canada to the South Sea." It is possible that the disputes between Spain and England about Nootka (now St. George's) Sound (on the west coast of Vancouver) and the adjacent regions, which nearly led to war but were settled by the Treaty of the Escurial in 1790, may have directed public attention to those little-known lands. More probably it was reported that attempts were being made to explore the north-west of Canada, and the Society wished to encourage them, and to identify itself with them. However, soon after the offer was made, Alexander Mackenzie completed the adventurous journey which brought him to the shores of the Pacific near the present boundary between Alaska and British Columbia. After exploring much of the north-west, and discovering the great river which now bears his name, he started in 1789 from Lake Athabasca to make a passage to the coast, which he reached in June 1793*. The richly-deserved gold medal was awarded to him in 1800, a rare, if not a unique, instance of an award made by the Society for exploration alone. About this time Mackenzie came to England, and in 1802 he was knighted by George III. He died in 1820.

In 1807 a silver medal was awarded to William Bond for a communication printed in the *Transactions*† containing information about Canadian industries and resources.

In 1816 Lieutenant-Colonel Joseph Bouchette, Government Surveyor to the Commission for settling the boundaries between the British colonies in North America and the United States, presented an extensive survey or map of Canada to the Society, for which he received the gold medal.

Mr. William Green, secretary of the Literary and Historical Society of Quebec, communicated to that society in 1827 a paper on colouring materials produced in Canada. The paper and a box of colours prepared from these materials were sent to the Society of Arts at the instance of the Earl of Dalhousie, Governor of Canada, and the Society in 1828 awarded a gold medal to Mr. Green for the pigments, which consisted of certain ochres and lakes, with some

* Morris's Cantor Lectures on Commercial Fibres (1895). *Journal*, Vol. XLIII. p. 923.

* A brief and singularly modest report of his journey by Mackenzie himself appears in the *Transactions*, Vol. XVIII. p. 289.

† Vol. XXV. p. 147.

colours of vegetable origin. They were pronounced by the authorities to whom they were referred for examination to be good, though perhaps the influence of the Governor-General had as much to do with the award as the importance of the products.

The first reference which has been discovered in the *Transactions* to the Australian colonies occurs in the volume containing the list of premiums for 1820, when two gold medals were offered, one for the greatest quantity of fine wool imported from New South Wales, and one for the finest sample of wool from the same colony. It is probable that the offer was prompted by the knowledge that Australian wool was being shipped to England, for in 1822 both medals were claimed by John McArthur, the "Father of New South Wales," and the founder of the Australian wool trade. McArthur had imported merino sheep from the Cape in 1795, and from that time he had devoted himself to the growth of wool on land near Sydney, which had been granted to him for the purpose by the Government. Whether this was his first consignment to London does not appear from the account of his labours given in the *Transactions*, but it amounted to over 15,000 lbs., and so complied with the conditions of the Society's offer. It is clear that the importation was in no sense the result of the offer, but the award of the medals, the report made by the Society on the high character of the wool, and the publicity gained by the account contained in the *Transactions*, appears to have helped considerably in making known the new and important source of supply thus opened up. At the instance of the Society, some cloth was made from the wool, and a silver medal was given to the manufacturers, Starkey, Buckley & Co., of Huddersfield.*

In the same year, 1821, a silver medal was given to John Raine for the importation of wool from Van Diemen's Land.

In 1824 a second gold medal was awarded to McArthur, and also a silver medal to Hannibal McArthur, a nephew of John, for the importation of the next greatest quantity of fine wool. Besides these, there were some prizes to manufacturers for cloth made from the wool, and after this the offer of rewards was dropped, the trade in Australian wool being established on a firm basis.

In 1822 a gold medal was offered for the importation of "the finest wine, not less than twenty gallons, of good marketable quality, made from the produce of vineyards in New South Wales." For some years this produced no response, but in 1833 a silver medal was presented to Mr. Gregory Blaxland for wine, the produce of his vineyard at Paramatta. "On examination by the Committee, it appeared to be a light but sound wine, with much of the odour and flavour of ordinary claret . . . though the present sample, from the inexpertness of the manufacture and the youth of the vine, is by no means of superior quality, yet it affords a reasonable ground of expectation that by care and time it may become a valuable article of export."

From a memorial to Governor Macquarrie from Mr. Blaxland, in October 1818, printed in the *Transactions*,* it appears that he was preparing his land for a vineyard in September 1816. He had really been anticipated by McArthur, who had started a vineyard, and had also planted olive-trees, some years before.

In 1828, a second medal, this time a gold one, was presented to Mr. Blaxland for a pipe of wine, the produce of his vineyard in 1827. "On tasting the samples, it was the general opinion that both of them are decidedly better than the wine for which, in 1823, Mr. Blaxland obtained the large silver medal of the Society, and that they were wholly free from the earthy flavour which unhappily characterises most of the Cape wines."

In 1824 the sum of thirty guineas was given to Mr. T. Kent, for preparing and importing from New South Wales extract of mimosa bark for the use of tanners, and in the following year (1825) a gold medal was awarded to Messrs. Petchey and Wood for similar material from Van Diemen's Land. In 1824 the thanks of the Society were presented to Mr. R. W. Horton, M.P., Under-Secretary for the Colonies and Vice-President of the Society, for sundry articles from New South Wales which he had presented.

There were a few, but not very many, other prizes to Australia. In 1830 a gold medal was voted to Sir John Jamison, President of the Agricultural Society of New South Wales, for his method of extirpating the stumps of trees in order to clear forest land for cultivation: and in 1834 a silver medal was awarded to James King, of Sydney, for his discovery of a sand in New South Wales, which was reported upon by Apsley Pellatt as being eminently fitted for the manufacture of the finer kinds of glass.

The award in 1775 of a small prize to a resident in Minorca for growing silk in that island is of interest, as reminding us that for

* *Transactions*, Vol. XL. pp. xiii. and 230.

* Vol. XLI. p. 236.

a brief period (1769-1782) Minorca was subject to this country, and was therefore included in the list of British colonies. After Malta was taken, in 1800, it also became eligible for the Society's awards, and so in 1811 a prize of a gold medal or fifty guineas was offered for Maltese silk. The offer was extended in 1819 to the "Isle of France" (Mauritius), which had been taken in 1810, possession being confirmed to England by the Treaty of Paris in 1814. The medal for Mauritius was taken in 1824 by M. de Chayal, who had been entrusted in 1815 with some silkworms' eggs obtained from Bengal by the Governor of the island, Sir R. T. Farquhar. The silk sent to London was reported on as being of good quality, but not first-class. In the Session of 1825-6 a gold medal was awarded to M. Barbé, of Mauritius, for the importation of cocoa-nut oil.

In 1822 an attempt was made to foster the growth of the vine at the Cape, which had then been definitely British about eight years, and a gold medal was offered to the person who should import the finest wine made from the produce of vineyards at the Cape of Good Hope, or the parts adjacent. It was announced that this premium was not offered for the sweet or Constantia wine, but to encourage the improvement of the vineyards more recently established. Viticulture had been introduced by the Dutch settlers in 1653, and developed by the Huguenot refugees in 1688. The premium was awarded in 1827 to Francis Collison, who stated that about three hundred pipes of the same quality had been sent by him for sale in the London market. "The wine was examined at the Committee by dealers and other competent judges, and was considered by them to be far superior to the Cape wines in general. It is free from the unpleasant, earthy flavour by which such wines are usually characterised, and was considered to bear a near resemblance to that made at Teneriffe."

SOME POINTS CONCERNING THE TREATMENT OF WHEATEN FLOUR.*

At the Leicester and Winnipeg meetings of this Association the author dealt with some phases of the complex questions concerning the quality of wheaten flour. Great importance must be attached to "strength," a flour's capacity for making big, shapely, and therefore well-aerated loaves. The nice appearance of food is a factor affecting its dietetic value. The whiteness of bread depends to a very great extent upon the "strength" of the flour used, for the good appearance of bread depends very largely on the perfect aeration of the loaf. "Strength" does not depend upon any one factor. A flour with a high protein-content is not necessarily strong. A flour with a low protein-content is probably, but not necessarily, weak.

The size of the loaf depends upon the production of sufficient gas during fermentation, more particularly during the later stages, and upon the gas-retaining capacity of the dough. The yeast must have a sufficiency of sugar, nitrogenous and mineral foods in forms which it can assimilate. Flour itself does not contain sufficient sugar for the requirements of the yeast. As a general proposition it is true to say that flour made from wheats harvested in moist atmospheric conditions yield as a result of diastatic action during panary fermentation a sufficient quantity of sugar, those harvested in hot dry conditions do not. The yeast requires its nitrogenous food in a very simple form. Flours containing a very high percentage of nitrogenous matter do not necessarily provide a sufficiency of nitrogenous yeast-food. It is believed that yeast can obtain all the mineral matter it requires from flour, but there are cases in which the addition of mineral phosphates does increase the yield of gas in panary fermentation conducted under commercial conditions. A flour may possess a high percentage of gluten, but unless it yields in fermentation sufficient gas to overcome the great and variable leak, and thoroughly to inflate the dough in the latest stages of the breadmaking process, it would be accounted weak.

Furthermore, a flour may yield more than sufficient gas at all stages of fermentation and may even possess a high percentage of nitrogenous matter and yet produce very small loaves. Dr. Hardy, at the Winnipeg meeting of this Association, showed that gluten loses its tenacity and ductility if it be deprived of its electrolytes. Professor T. B. Wood has demonstrated the profound influence which very dilute solutions of acids, alkalis, and salts have on the physical characteristics of gluten. It has been found that additions of very small percentages of salts natural to flour or wheaten ash do increase the size of the loaf, even though the production of gas in fermentation be unaffected or actually diminished.

The author came across a case in which the mere addition of water, if made at a time substantially prior to dough making, increased the strength of the flour to an extraordinary extent, even though the yield of gas in fermentation was not appreciably increased thereby.

He therefore, with the assistance of his colleague, Mr. A. G. Simpson, made an investigation of the changes produced, the results of which were set forth in detail. The most striking change in the flour itself appears to be the transformation of organic phosphorus compounds into inorganic. As part of these investigations, it has been found

* Abstract of a paper read by Mr. A. E. Humphries before the Chemical Section of the British Association at Portsmouth, 1911.

that during the process of baking a large proportion of these compounds becomes inorganic.

British millers nowadays obtain their raw material from all parts of the world, a multitude of varieties being raised in environments ranging from arctic or semi-arctic to tropical or semi-tropical. The climatic conditions in most districts also vary greatly from season to season. From such extremely diverse and variable materials they have to produce flours of uniform qualities. It is therefore right and proper that they should be allowed to make use of the advances in chemical knowledge in the treatment of wheats and flours. Sometimes the desirable treatment can be limited to the adjustment of water content, nature herself being thereby enabled to effect the necessary changes.

Sometimes the addition of water fails to bring about these changes, or for various reasons it is undesirable to raise the water content sufficiently, and in such cases the addition of diastatic bodies, nitrogenous yeast-foods and salts natural to wheat or wheaten ash is desirable and should be permitted. But inasmuch as such permission might be abused, a board of reference, consisting of highly qualified physiologists, chemists, and business men, should be established, to whom all such processes and additions should be submitted, and to whom millers and bakers should be responsible in such matters.

TOMATO PRESERVING IN FRANCE.

The preserving of the tomato is an important industry in the south of France and Italy, where the use of this fruit in cookery is far more general than it is in England and more northern countries. On the French Riviera tomato packing and preserving is carried on, on a considerable scale, during the summer months in small factories.

In a typical establishment at Antibes, about twelve miles west of Nice, employing three men and eight women, capable of dealing with twenty tons of the fruit per day, two different processes are carried on, viz.—first, the packing of tomatoes in slices (*tomates à moitié*); second, the manufacture of the paste, or *purée*, which is also put up in tins.

The first is a very simple operation, and is comcommenced as early as possible in the season, that is to say, as soon as the fruit is sufficiently plentiful and cheap.

The tomatoes are cut into halves, and slightly pressed between the fingers to get rid of the seeds and excess of liquid. They are then packed in tins containing one kilogram (about 2½ lbs.) each, at the rate of about sixteen halves of a medium-sized tomato to each tin, which is then filled up with a solution of common salt and water, of a density of 3° by the salinometer. The tins are then hermetically closed.

The sterilisation is effected by placing the tins in a *bain-marie*, heated to boiling-point for about two hours. The tins are placed in a sort of cage suspended from a pulley running on a rail above one of the four open boilers into which the cage can be lowered. During the busy season it is possible to shorten the time necessary for sterilisation by the use of a closed vessel, termed "autoclave," in which the tins are heated under pressure to a higher temperature than is the case with the open *bain-marie*. By means of this apparatus the time necessary for sterilisation can be reduced from two hours to one hour when heated to 105° C. (221° F.); three-quarters of an hour to 110° C. (230° F.); half an hour to 112° C. (233° F.) and even to twenty minutes if heated to 115° C. (239° F).

The preparation of the paste or *purée*, is usually commenced as soon as the fruit is plentiful, and the price as low as four to five francs per hundred kilogs (1*s*. 8*d*. to 2*s*. per cwt.).

The fruit is emptied into the hopper of a squeezing machine (similar to those used for crushing grapes) placed above an open boiler, into which the crushed tomatoes fall. This boiler is capable of holding 3,000 kilogs (about three tons) of pulp. The operation of boiling facilitates the separation of the seeds and skins. The boiled pulp is drawn off from the bottom of the pan into vats.

The next operation is the removal of the seeds and skins. This is done in a cylindrical strainer, into which the pulp is poured. Here it is kept constantly stirred by rotary *malaxeurs*, or stirrers, which force the pulp against the perforated sides of the cylinder, whilst the skins, seeds and refuse fall into a receiver.

The strained pulp, or *purée*, is next heated in smaller pans, having a capacity of about 250 kilogs (about 5 cwt.) each, until the right degree of concentration is obtained. The finished *purée*, or paste, is put up in tins of various sizes, ranging from one-tenth kilog. to one kilog. in capacity. After being closed hermetically the tins are sterilised in a *bain-marie* at boiling-point 212° F. for about three-quarters of an hour.

During a busy season, when time cannot be spared for packing a large number of small-sized tins, it is customary to store up a certain quantity of the paste in ten kilog. (22 lbs.) tins. The sterilisation of these store tins requires about two hours. These are re-packed into the small sizes as required during the slack season.

Formerly it was the practice to bottle the *purée*, but of late years, owing to competition by Italian firms, tins are used exclusively.

An inferior quality of tomato paste is prepared from the skins which, after being boiled with a certain quantity of water, are passed through the strainer. The *purée* so obtained, with the addition of salt, is concentrated by boiling and put up into small casks. It is supplied in this form chiefly to the small retailers.

An excellent preserve can also be prepared from tomato *purée* by boiling it with an equal weight of sugar, and adding powdered ginger and the juice and grated rinds of lemons to taste.

This, however, is not made on a commercial scale in factories, but only as a dainty in private houses.

THE FRUIT INDUSTRY OF CUBA.

Cuba has a wide range of fruits, some of which are very strange to the foreigner. The plum (ciruela) grows directly from the branches of the tree with no stems. The fruit is somewhat astringent, which however is not disagreeable when one is accustomed to it. The mango pertains to the peach family, the trees grow to a large size and bear a fruit which has a shape similar to a peach but is more oblong. The peel is smooth and thick and is easily removed. The fruit has a large seed covered with a fibrous growth which threads itself through the meat, is very luscious and very much prized, but many persons do not like it because of the slight taste of turpentine in it. The aguacate, or alligator pear, grows to perfection, and is used for salads. In size and shape it is not unlike a large pear. The sugar apple is very sweet, with mealy sugary interior. The sour sop (guanabana) is of the same family as the sugar apple. It is used largely in the preparation of refreshing drinks, in ices and ice-cream. The sapodilla (zapote) is a flat round fruit, about the size of a golf ball, and in colour resembles an Irish potato. There are several varieties of this fruit. The caimito is a combination of the plum and the fig. Some caimitos are green, and others have a purple exterior. They are very palatable, and are filled with a soft jelly-like substance with an agreeable juice. The mamoncillo is a small round, green or russet fruit about the size of a large marble, filled with a very acid juice. It has very little meat, as the large seed leaves little room for the juice and the yellowish meat which surrounds it. This fruit makes a delicious drink. The guava is used for making exceptionally fine jellies, marmalades and preserves. The peel is occasionally used in a home-made brew of beer. Guavas grow in great abundance throughout Cuba on bushes and small-sized trees. The mamey Colorado grows on large trees, and is a fruit resembling a russet apple in colour and about the size and shape of an ostrich egg. The fig grows well in Cuba, the black green and Smyrna varieties all thrive, but, according to a recent report of the Cuban Ministry of Agriculture, no effort has been made to cultivate them since the retirement of the Spanish Government. Before that time the cultivation of this fruit was prohibited, except one tree which was allowed to each family. This was said to have been done to protect the home (Spanish) industry. The same laws also existed against the cultivation of grapes during the Spanish sovereignty. There are, however, old grape vines in Cuba which have never had any cultivation, but which are prolific bearers of excellent fruit, and thus show what an opportunity awaits those who will engage in the intelligent cultivation of the grape in Cuba. In connection with this it may be said that there is probably no country in the world which consumes so much wine *per capita* and produces less. Pineapples and oranges are grown in Cuba. As regards the latter, the fruit is very fine, and when the young groves now coming into bearing more fully develop, Cuba will make a strong bid for a high place in the fruit market of the world. Bananas grow to perfection, particularly in the eastern part of the island, where large banana plantations are under cultivation, more than 99 per cent. of the production going to the United States. In addition to the banana which is eaten as a fruit, there is another variety known as plaintain, which is used for cooking purposes. Green plaintains when cut thin and fried are much appreciated in Cuba, and are said to be far more nutritious than potatoes. They are also used in soups and stews, and are baked and prepared in many ways.

EMPIRE NOTES.

The Development of Nova Scotia.—No province of the North American continent surpasses Nova Scotia in the variety of its natural resources. The publicity which is being given to the Canadian West and Middle West and their wide development has diverted attention, somewhat, from the steady expansion of Nova Scotia. Numerous towns have sprung up even during the past few months, and many hitherto small townships are becoming prosperous manufacturing centres. Notably among the latter is New Waterford, in Cape Breton County. Near this township a large workable seam of coal was recently located, and five new collieries have been started. The population has been rapidly increasing, and the prospects suggest that New Waterford may eventually become the largest mining town in Eastern Canada. A considerable increase in trade at Louisburg has led to the suggestion being put forward that this town should be made the Canadian Fishguard. Fast trains could take passengers and mails from the steamers and run through to Montreal, Toronto, Boston, and New York, as well as to the Far West, at, it is said, a saving of many hours, and even days. According to recent returns, some 5,000 ocean liners have loaded and unloaded at the various wharves along the coast. These represent an aggregate tonnage of 5,000,000 tons. Then again there is the great inter-provincial trade, for which about 25,000 vessels are delivering 6,000,000 tons of freight annually. The Harbour Commissioners, though naturally elate at this success, do not intend to rest on their laurels, as it is estimated £500,000 will have been spent this year on increasing the shipping facilities. The railway system is also being extended to the Racine Pier, and another pier is being built in Market Basin. Additional facilities, too, are being provided at St. Helen's Island, and a number of new warehouses and reinforced-concrete freight-sheds are to be built, while the diversion of the St. Mary's current, by alteration of the McKay Pier, and preparations for the new dock are either in hand or shortly to be commenced. A large manganese deposit has been discovered at New Ross, Lunenburg County. The ore is reported to be

exceptionally free from iron. The vein is from 4 ins. to 48 ins. wide, and dips vertically. It is moreover stated that the ore is the very best grade known, and is suitable for use in glass works, varnish manufactories, and the making of dry batteries.

Financing Canadian Crops.—Under the Canadian Bank Act a measure of relief has been extended to Canadian banks, whereby, during the months of September, October, November, and December, an issue of notes equal to 15 per cent. of the combined capital and reserve can be made, in addition to their existing note issue. The reason for the adoption of this important step is said to be the ever-increasing call for banking accommodation, pending the movements of the crops, as during this period the fear of temporary money stringency is never absent. The additional circulation is to be covered, as is the normal note issue, by the collective guarantee of the banks. The emergency issue, however, is subject to a tax of 4 per cent. Since this tax absorbs practically the whole of the profits from the issue, there is no inducement to the banks to avail themselves of it, except as a temporary convenience, the provision for which is a further proof of the public-spirited policy of the Canadian Government.

A United States Delegation to Visit Australasia.—The question of closer commercial relationship between the United States and Australasia, as well as between Canada and Australasia, is evidently to the fore. Mr. Percy Hunter, of Sydney, New South Wales, has recently been touring through North America, with a view to securing the interest of American business men in the development of the Commonwealth. That his tour has been successful is proved by the fact that the Spokane Chamber of Commerce is organising a delegation to visit Australia and New Zealand to inquire into the economic and trade prospects of those countries. Representative business men are being invited from all the States of the Union to join the party, and it is anticipated that a hundred gentlemen will respond to the invitations. An interesting itinerary has been arranged, embracing Fiji, New Zealand, New South Wales, Queensland, Victoria, South Australia, Western Australia, and back *viâ* Auckland, New Zealand. In all, twenty-eight days will be spent in Australia, and the delegates intend to study, not only the openings for capital, but also the municipal politics of the cities and communities visited. The Spokane Chamber of Commerce expresses the hope that a deputation of Australasians will return the visit, and considers that a study of each other's business methods and a more intimate knowledge of each other's social development will prove of great benefit to these two important branches of the Anglo-Saxon race.

Public Works Programme for New Zealand.—Those interested in the public works policy of New Zealand will read with interest the important proposals submitted by the Hon. R. McKenzie, the Minister for Public Works. Speaking at Wakefield, N.Z., he said that £28,000,000 would be required—for the purpose of providing £18,000,000 for railway extension; £3,000,000 for public buildings and schools; £4,000,000 for road-making; £2,000,000 for harnessing water-power for the generation and distribution of electricity and for irrigation; and £1,000,000 for telegraphic extension and harbours. He laid stress on the advantages of hydro-electric force, and pointed out the necessity of keeping pace with the phenomenal growth of the Dominion in respect of railways, roads, telephones, and public buildings. He also outlined the policy of the Government in regard to financing these various undertakings, and pointed out three ways whereby it can be accomplished—viz., by means of loans, out of taxation, or by a fusion of loans and surpluses. The last method seems to be the one that is likely to be adopted, and he suggests that £1,500,000 a year shall be provided, by borrowing £1,000,000 and budgetting £500,000. He urged the necessity of undertaking and completing these works within a reasonable time, and pointed out that money borrowed and invested in reproductive works would earn its own interest.

Irrigation and Beet-Growing in Victoria.—In a recent issue, attention was directed to the forward policy of certain of the Australian State Governments in the matter of irrigation. This method of fertilisation has become essential in various parts of the island continent, and, in pursuance of the Government's land development and settlement proposals, a beginning has been made by the Victorian Water Commission, with one of the largest and most important irrigation schemes yet attempted in that State. It is proposed to construct a weir across the Murray River, near Kow Swamp, for the purpose of conserving, for irrigation purposes, many millions of gallons of water now flowing into the sea. Preliminary steps have been taken for carrying the scheme into effect, and the estimated cost is only £100,000. A great tract of the northern irrigation areas will benefit by the undertaking, as, when the weir is built, water will be carried, by gravitation, many miles through some of the most productive land in Victoria. In the matter of sugar-beet cultivation, Victoria has been attempting to establish this industry on a sound commercial basis for many years. Up to the present time, however, nothing of a substantial nature has been accomplished. In view of this, a report of the prospects in Gippsland, from the Director of Agriculture, is of some interest. The Director says that "A recent and thorough inspection of the Boisdale land suggests the likelihood that, as regards beet growing, the land will readily, under proper cultivation, yield twenty tons per acre of 'topped' beets, which will be paid for at the rate of £1 per ton delivered. Twenty-four tons to the acre were being delivered from Powerscourt, adjoining, on the day of my visit. Setting down the

cost of cultivation and freight even at the high rate of £10 per acre, a net return of £100 from the ten-acre plots may be expected, while the yearly purchase payments of the full blocks average less than £68. Assuming that only seventeen tons per acre is produced, then the net profit on the ten acres will be more than sufficient to pay the average annual purchase payments on the whole area of the block. The area not under beet each year should be devoted to dairying under intense culture, and the quality of the land for this purpose may be judged by the fact that some of the farms have been carrying a cow to one and a half acres, so that under good management from twenty to twenty-five cows can be kept on the balance of land costing nothing—purchase payments of the whole being returned by the beet crop each year. The project of the Government in assisting settlement on this estate for beet growing and dairying combined is therefore, I consider, the finest opportunity that has been yet offered in connection with the closer settlement movement. With the factory already established, the sugar market practically illimitable, and the dairy export trade constant, I cannot see how the project can fail if the right class of settler is secured." The factory referred to is located at Maffra, Gippsland, and had for a considerable time been idle. There appears now to be some reason to hope that a large and profitable sugar-beet industry will become established.

The French Explorers of Australia.—It is often forgotten that French explorers played a very large part in the discovery of various parts of Australia. In Western Australia and Tasmania, and also in New South Wales, there are names which indicate their French origin. Notable amongst these are Cape Naturaliste, Geographe Bay, and Cape D'Entrecasteaux, in Western Australia. The names of the first two were derived from the two French frigates that entered the splendid bay, on which the prosperous town of Busselton now stands, towards the latter end of the eighteenth century, and the Point D'Entrecasteaux was named after D'Entrecasteaux, who located various points in Tasmania. Cape Jervis in New South Wales was at first called the Fleurieu Peninsula, and the Council of the South Australian Geographical Society has recently decided to ask the Commonwealth Government to revert to its original French name, which it has borne on French maps since it was so named by Baudin's expedition. At the present moment Count Alphonse de Fleurieu, a member of the Paris Geographical Society, is in Tasmania, with the object of following the course of these early French pioneers. The Count states that he has gathered a good deal of information from various sources with regard to the early exploration of Tasmania, with which his great-uncle was closely connected as the organiser of expeditions. He is specially interested in the voyages of D'Entrecasteaux and Baudin.

NOTES ON BOOKS.

THE CRYSTAL PALACE, SYDENHAM. Messrs. Horne & Co. and Others.

This handsome folio, which purports only to be the auctioneers' catalogue for the sale of the Crystal Palace in November next, is really a very finely illustrated account of the origin and history of the Palace. There must be some fifty or more well-executed photogravures, reproduced from engravings, prints, and photographs, which have at various times been published in illustration of the Palace and its contents, the history of its erection in Hyde Park and transfer to Sydenham, and of various events in its career. Besides these illustrations there is a historical sketch tracing the history of the Crystal Palace from the time when the Great Exhibition of 1851 was first proposed down to the present date.

The account of the origin of the Exhibition is accurate, though naturally very brief. It would be easy to amplify it, and it is certainly an omission that no reference is made to the name of Sir Henry Cole, to whom, more than to anyone else, except perhaps the Prince Consort, is due the successful carrying out of the great scheme. There would never have been an exhibition if Prince Albert had not used his great influence in its favour, and it would never have been the success it was but for the energy and organising capacity of Mr. Henry Cole, C.B., as he then was. But the book does not purport to be a complete history of the Exhibition of 1851. What it purports to be is an illustrated account of the Crystal Palace and its contents, and in this aim it has succeeded extremely well.

GENERAL NOTES.

AGRICULTURAL INSTRUCTION DURING WINTER IN FRANCE.—The opening of classes during the winter months, for instruction in agriculture, has given good results. Until quite recently, little had been done in France towards following the example set by other nations in Europe, where winter schools have been in existence for many years past. In Germany there are no fewer than one hundred and eighteen of these schools, which are frequented by the sons of small proprietors and farmers, who could not spare them from home during the busy times of haymaking, harvest, vintage, etc. Austria has sixty-seven, and in Holland there are six. In France, however, little was done in this direction until 1900, when M. Léon Dabat, then a sub-inspector of agriculture, in a report to the International Jury of the Paris Exhibition, pointed out the necessity of such instruction. The first school of this kind was opened in 1902 at Langres, where the existing college buildings and teaching staff are utilised. This example was followed at Troyes, where there

is another winter school, aided by subsidies from the various societies of Agriculture, Horticulture, Viticulture and Forestry of the Department of Aube. These were followed by Lons-le-Saulnier in 1907, and Chartres in 1908; a winter course of practical agriculture will be opened this year at the Lycée of Chaumont, and another on viticulture at the College of Épernay, in the heart of the wine-growing district; other schools will be eventually established throughout the country. The course of instruction at these schools covers a period of two years. Each school is under the direction of a professor of agriculture, who gives instruction in that subject, as well as in viticulture or forestry. For the remainder of the curriculum he is assisted by the local professors; this includes geometry, land-surveying, drawing, physics and chemistry. Instruction in veterinary science and hygiene is given by a local veterinary surgeon, whilst lessons in first aid and domestic hygiene are occasionally given by one of the doctors attached to the hospital of the town.

Imports of Grapes to Germany.—According to a recent report from Berlin, the importation of grapes for wine-making into Germany has increased considerably during the last four years, as is shown by the following statistics. These figures do not include table grapes, of which large quantities are sent from Italy, and are given in metric quintals.*

Country.	1907.	1908.	1909.	1910.
Italy	41,260	66,740	66,440	172,097
Spain	105,927	72,313	70,140	119,183
Austria-Hungary	29,227	36,301	22,622	79,254
France	212,688	193,862	158,399	55,945
Greece	—	—	6,978	5,801
Other Countries	10,764	7,764	7,882	45,719
Quintals	399,866	376,980	332,461	477,999

This great falling off in the quantity of grapes imported from France is due to the increase of price in 1910 as compared with that of previous years. On the other hand, the wine-makers of the Rhine provinces, Würtemburg, and of Alsace-Lorraine, have made up the deficiency by purchasing grapes at cheaper rates in Italy, from the vineyards of Romagna, Modena and Mantua. In this way Italy has risen from the third place which she held before to become the chief source of supply.

French Trade with Algeria. — Algeria is undergoing a period of exceptional prosperity at the present time. The total value of the exports and the imports between that country and France has increased from 632,700,000 francs (£25,268,000) in 1909 to 825,334,000 francs (£33,013,360) in 1910, showing an increase of 193,634,000 francs (£7,765,360) in favour of last year. The exports from Algeria to France, which in 1909 amounted in value to 271 million francs (£10,840,000), in 1910 increased to 360 million francs (£15,600,000). This increase of 119 million francs (£4,760,000) may, to a great extent, be attributed to the bad harvest that year in France, causing her to draw upon the resources of the colony to make up for the deficiency. The following shows the quantities of some of the principal products of Algeria exported to France in 1910, as compared with those of 1909:—

	1909.	1910.
Grain	234,480 tons.	340,200 tons.
Wine	6,047,000 hectolitres (132,994,000 gallons)	6,693,174 hectolitres (147,249,828 gallons).
Olive Oil	15,000 quintals (about 30,000 cwts.)	79,000 quintals (about 158,000 cwts.)
Vegetables	18,408 tons.	23,400 tons.

The value of land in the colony has considerably increased during the last few years. Wine-growers in this more favoured climate are reaping a benefit from higher prices, due to the deficiency of the grape crop last year. The Bureau de Renseignements, established by the Algerian Government, is found to render good service to colonial farmers in pointing out markets in France for their produce.

The Imports of Motor-cars to Norway.—The imports of motor-cars by Norway during 1909 show a considerable increase in value as compared with those of the previous year. This is especially noticeable with regard to cars of French make. There has been, however, no falling off in the value of cars imported from other countries, as is shown by the following:—

Value of Motor Cars imported.

	1908. *Crowns.	1908. £ sterling.		1909. Crowns.	1909. £ sterling.
Germany	135,800	7,356	..	186,000	10,075
Great Britain	137,700	7,459	..	176,700	9,571
France	27,000	1,462	..	117,100	6,343
United States	10,800	585	..	56,300	3,050

Norway also promises to become a good customer for machinery for motor-boats. The motor is steadily taking the place of the sail in the extensive fishing fleet of that country. Although the manufacture of these motors is carried on successfully in Norway, the value of those imported from other countries during 1909 amounted to 1,557,100 crowns (£84,343). France only figured in this amount to the value of 1,700 crowns (£92).

Sericiculture in Hungary.—Sericiculture is an industry which has made considerable headway in Hungary during the last thirty years. In 1879 only 2,507 kilograms (5,528 lbs.) of cocoons, representing a profit of 7,400 crowns† (£308 sterling), were produced. Last year the production of cocoons had increased to 1,644,972 kilograms (3,627,163 lbs.), giving employment to 90,064 families, and realising a profit of 5,179,382 crowns (£215,808).

* Metric quintal = 220½ English pounds.

* Norwegian crown = 1s 1d. † 24 crowns = £1 sterling.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

ROCK CRYSTAL: ITS STRUCTURE AND USES.

By Alfred E. H. Tutton, M.A., D.Sc., F.R.S.

Lecture I.—Delivered May 1st, 1911.

Rock crystal, quartz, the common crystallised form of silica, dioxide of silicon, SiO_2, is, from many points of view, the most interesting of all minerals, and forms the most instructive example of crystalline structure known to us, displaying the physical properties of organised solids, crystals, in a uniquely complete and perfect manner. From the fact of its ubiquitous presence the world over—silica being, after water, the oxide most largely developed in the accessible part of the earth—rock crystal was the first crystallised mineral to attract the attention of the ancient philosophers. Indeed, this mineral actually gave its name to the whole science of the crystal—"crystallography," for the word "crystal" is the anglicised Greek word for ice, κρύσταλλος, the ancients having believed that rock crystal was a form of ice produced by the severe cold of the higher regions of the Alps. It is especially interesting that Pliny should have left us the following passage of remarkable insight regarding rock crystal, in Book xxxvii. 9 of his "Natural History": *Quare sexangulis nascatur lateribus non facile ratio inveniri potest; eo magis quod neque mucronis eadem species est, et ita absolutus est laterum lævor, ut nulla id arte possit æquari.* Pliny had thus obviously remarked the hexagonal prismatic form of the crystals, and found it difficult to account for such regularity of form, and particularly for the varied appearance of the pyramidally-pointed ends; he also noticed the wonderful polish of the prism faces, which he considered to be such as no man could equal.

The popular belief, in the Middle Ages, that rock crystal was a harder form of ice is very plainly stated by Albertus Magnus about the year 1250; for he says that the high mountains make the ice so hard and dry that it becomes "crystal," *ex illo sicco coagulat glaciem in crystallum.* Even as late as 1550 Agricola was only able to report progress in the knowledge of rock crystal to the extent that it was not ice, but a denser product of cold, *succus frigore densatus.*

A very curious passage occurs in the writings of our own Sir John Mandeville of the year 1356, in which he states that "diamonds grow on rocks of crystal" in Indo-China, and that "they grow together, male and female, and are nourished by the dew of heaven. . . . If a man keep them with a little of the rock, and wet them with May-dew often, they shall grow every year, and the small will grow great." Thus we have here a remarkable record of the growth of crystals, and an early observation of the fact that precious stones and metals are often found associated with rock crystal, unless Sir John mistook the more perfectly-developed crystals of quartz for diamonds.

In the year 1669, a far-seeing treatise, *De solido intra solidum naturaliter contento*, was published by Nicolaus Steno, a Dane resident in Florence, in which the first real steps in crystallography were taken, all derived from the study of rock crystal. He showed that the prism was of truly hexagonal section, the angles being all 60°, and the terminations hexagonal pyramids, the apices of which in an ideally-formed crystal might be considered to be joined by the axis of the prism. He entirely rejected the idea of cold as the cause of the formation of rock crystal, and suggested a magnetic force of crystallisation. Being a great authority on anatomy, he pointed out that the growth of the crystal differed from that of living objects, which grow from within, in occurring by accretions from without, of minute particles of the

substance of which they are composed, carried in solution by a liquid. He showed further that growth occurred chiefly at the ends, as indicated by the transverse striæ on the prism faces, which he considered as growth marks. Moreover, he was the first to discover, or at any rate to record, the fundamentally important fact that the angles between the faces, that is, their mutual inclinations, were always the same, whatever the relative development of the faces might be.

This fact was further confirmed between the years 1688 and 1707 by Guglielmini, whose memoirs, moreover, relate also to other crystalline substances besides rock crystal, and the constancy of the angular magnitudes between the crystal faces of any one substance was extended by him into a great law of Nature. About this time also Huyghens—who had been studying the double refraction of Iceland spar, the wonderfully clear rhombohedral form of calcium carbonate, $CaCO_3$, which had then recently (1670) been discovered at Eskifjördhr, in Iceland, and its birefringence observed by Bartolinus—pointed out the further fact that rock crystal also possesses the property of double refraction, although to a much less extent than Iceland spar.

It will thus be seen what a large share the study of rock crystal has had in the pioneer work of unravelling the nature of crystals. If it should be desired to follow further the history of the development of crystallography, from the end of the seventeenth century to the present time, a concise account will be found in the lecturer's book on "Crystals" (Kegan Paul, International Scientific Series, 1911); and any who desire to undertake still deeper study and to carry out original investigation will find useful the lecturer's larger work, "Crystallography and Practical Crystal Measurement" (Macmillan, 1911).

After a few words about the origin and occurrence of quartz, we may pass on to inquire what is the modern conception of a crystal in general, and then to elucidate the particular inner structure of this wonderful mineral, quartz, to which it owes both its exterior shape and its physical properties.

That silicon dioxide, SiO_2, is the most abundant of all the naturally-occurring solid oxides is responsible for the very common occurrence of quartz in good crystals. For water, especially when it is slightly alkaline (with carbonates or hydrates of the alkalies) and warm, and still more when under pressure, is capable of dissolving quite appreciable quantities of silicon dioxide; in the case of the presence of free alkali, soda or potash, a soluble silicate of sodium or potassium may be formed, which, under certain circumstances (the reaction being a reversible one), in contact with carbonic acid derived by solution of atmospheric carbon dioxide in water, becomes decomposed to carbonate of the metal with liberation of free silicon dioxide. According to the circumstances, and especially as to whether the deposition is rapid or slow, the silica takes the form of opal or other amorphous variety of silicon dioxide, of clear crystals of quartz, or of agate or other semi-crystalline variety. The long periods of time during which slow processes are at work in Nature is doubtless the cause of the formation of the most perfect and beautiful crystals of the well-known minerals, and some such mode of formation is probably responsible for most of the development of quartz crystals in cracks and crevices of the earth's crust, so plentiful in mountainous districts.

Besides the deposition of quartz from the state of solution, however, volcanic action is responsible for the crystallisation of quartz from the fused rocks in deep-seated cavities; for the more acidic rocks (those containing the largest proportion of silica, a feeble acid, either combined in silicates or as free quartz), such as granites, quartz porphyries and rhyolites, contain innumerable crystals of free silicon dioxide, quartz, which are clearly revealed by their brilliant transparency when very thin slices of the rocks are cut, ground and polished for examination under the microscope, and particularly by the brilliant colours of Newton's first or second order spectra which are afforded when polarised light is used. We see this particularly well in the cases of the microscope slides of graphic granite, muscovite granite, and quartz porphyry exhibited on the screen with the aid of the projection polarising microscope. Here we have the case of the crystallisation of silicon dioxide from the molten state, in the midst of a magma itself more or less crystalline, exhibiting crystals of felspar and mica or hornblende, or a micro-crystalline (quartz porphyry) or crypto-crystalline (rhyolite) base in which the quartz crystals are very clearly marked, although their margins have often lost the hexagonal form owing to having been eaten into by the basal magma. Whatever be the mode of origin, however, the chief point to observe is that the internal structure of all perfectly-developed crystals of quartz is identical.

Indeed, the most wonderful thing about a

crystal, and one which is especially emphasised by quartz, is that whether it be of microscopic dimensions or of huge size, the structure is the same, and when the external parts are properly developed the faces are of the same character, inclined to each other at exactly the same angles.

Large crystals of quartz have been known from very early times, and were used even by the Romans as transparent material out of which to fashion "crystal" cups and vases, as will be more particularly referred to in the fourth lecture. Some very fine specimens of early carvings of ornamental vases of rock crystal are exhibited in the Waddesdon room of the Rothschild collection at the British Museum. The Alps have always proved fertile in cavities containing large crystals of quartz, one at Zinken, to which attention has recently been called by Mr. Cheshire, having been discovered early in the last century, with roof, walls, and floor lined with masses of magnificent large crystals, of which 50 tons were removed; the largest crystal weighed 800 lbs., and was placed in the Natural History Museum of Paris by the great Napoleon. More recently, in 1867, a cavity was discovered in a vein of smoky quartz from which 200 tons of crystals were removed, the largest weighing 250 lbs.

But the most remarkable find with which the lecturer is acquainted was that made in December, 1897, by Mr. J. E. Burton, at the old Green Mountain mine, Mokelumne Hill, Calaveras County, California. Particulars of this discovery the lecturer owes to the kindness of his friend, Mr. C. V. Boys, who is also a friend of the discoverer. Among a considerable number of large crystals, Mr. Burton eventually came across one, which was successfully removed after encountering many engineering and transport difficulties, which measured 11 ft. 7 ins. in circumference and 4 ft. 2 ins. in length, and the weight of which was just over 2,200 lbs., almost exactly a ton. It was of quite remarkable purity for so large a crystal, and was surrounded at the base by forty-seven smaller crystals which assisted in protecting it from injury, the weight of the whole mass being 2,630 lbs. It was secured by the well-known firm of Tiffany, of New York, for the cutting of crystal-gazing spheres, the largest being a sphere of 14 ins. diameter of clear crystal, besides several smaller ones of 8 ins. A sphere of rock crystal of 8 ins. diameter was already at that time in the possession of Miss Jay Gould, having been made in Japan from a large Japanese crystal of quartz. Indeed, the Japanese have long been known to be specially skilled in the cutting and polishing of rock crystal, and have been famous for the production of large spheres of rock crystal for "crystal-gazing" purposes, two of somewhat smaller size being shown on the table.

Passing now to the discussion of the question "What is a crystal?" we are in a position to state at once that the evidence is now overwhelmingly complete that a crystal is a homogeneous structure built up on the plan of a space-lattice, each of the unit cells of which is the habitat of a chemical molecule of the substance of which the crystal is composed, and of which it is the most highly organised solid form. Instead of regarding the centres of the cells, however, as the points representative of the structural units, we may equally well, by moving

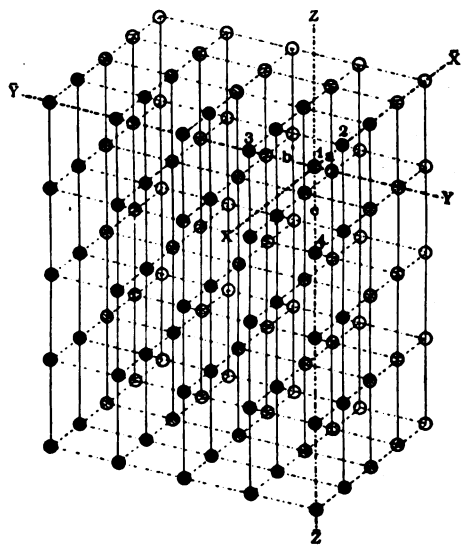

FIG. 1.—TRICLINIC SPACE-LATTICE.

them all equally parallel to themselves in imagination, consider the points or "nodes" of intersection of the three sets of parallel lines (the edges of the cells, the nodes being the corners of the cells) as the points representative of the chemical molecules. It was shown by Frankenheim and Bravais that there are fourteen such space-lattices possible, all of which show the full symmetry of one or other of the seven crystal systems, the cubic, trigonal, tetragonal, hexagonal, rhombic, monoclinic, or triclinic. As a typical example of a space-lattice, and the one of the most general form, the triclinic space-lattice is shown in Fig. 1.

But the chemical molecules, the arrangement of which thus determines the crystal system,

are not the ultimate units, being composed of elementary atoms, and it is the arrangement of these ultimate units, the elementary atoms, which determines the class of the system. For besides that class of each system which exhibits the maximum symmetry possible to the system, the so-called holohedral class, there are one or more (as many as seven in the cases of the trigonal and tetragonal classes) other classes possible which exhibit only partially, and in more than one way, the symmetry of the system, while conforming to the minimum symmetry essential to the system. Thus the cubic and hexagonal systems comprise each five classes, the rhombic and monoclinic each three, and the triclinic two classes, making with the fourteen already referred to belonging to the trigonal and tetragonal systems no less than thirty-two classes of crystal symmetry, each characterised by its own specific elements of symmetry.

The elements or criteria of symmetry are planes and axes of symmetry. A plane of symmetry is obviously a plane on each side of which the disposition of the parts of the crystal is similar, one half being the mirror-image of the other half, the plane of symmetry being regarded as the reflecting surface of the mirror. An axis of symmetry is such that rotation of the crystal around it for a definite aliquot part of a circle, which may be 180°, 120°, 90°, or 60°, brings the crystal to look precisely as it did before the rotation. The four kinds of axes of symmetry corresponding to rotations of the four amounts just specified are termed digonal, trigonal, tetragonal, and hexagonal axes, as two, three, four, and six such rotations respectively bring the crystal into the identical position started with.

Now the possession of a single hexagonal, tetragonal, or trigonal axis of symmetry is the characteristic of the three respective systems named after these specific axes, and quartz belongs to the third of these systems, the trigonal. Digonal axes, one or more according to the system, are common to all the seven crystal systems except the triclinic, which latter is either entirely unsymmetrical or in its holohedral class is symmetrical to the centre, that is, a holohedral triclinic crystal is composed of pairs of parallel faces. But the rhombic system is the one pre-eminently characterised by digonal axes of symmetry, there being three possible, identical in direction with the rectangular but unequal crystallographic axes of reference. The monoclinic system possesses one such digonal axis, which is perpendicular to the unique plane of symmetry possessed by the crystal. The system of highest symmetry, however, is extremely rich both in planes and axes of symmetry, its supreme holohedral class possessing no fewer than nine planes and thirteen axes of symmetry, of which six are digonal, four trigonal, and three tetragonal axes. Thus a holohedral cubic crystal, such as a garnet for instance, is endowed with no less than twenty-two elements of symmetry.

Symmetry axes must not be confused with the crystal axes of reference. These latter are three in number in all the systems but the hexagonal, in which four are employed, three being horizontal ones inclined at 60° to each other, while the fourth, identical in direction with the hexagonal axis of symmetry and usually arranged vertically, is perpendicular to the three just referred to. These axes are parallel to the edges of the hexagonal prism terminated by a pair of flat normal end-faces, the so-called basal-plane faces. In the cubic, tetragonal, and rhombic systems the crystallographic axes intersect rectangularly and are parallel to the edges of the cube, the tetragonal prism, and the rectangular rhombic solid formed by the primary faces (pinakoids) of the rhombic system analogous to those of the cube; the three axes are of equal length in the case of the cube, and are identical in direction with the tetragonal axes of symmetry; two are equal in the case of the tetragonal axes, the third axis of different length being identical in direction with the tetragonal axis of symmetry; while in the rhombic system all three axes are unequal. In the monoclinic system the three unequal axes are like the rhombic ones, except that one of them is inclined to the plane of the other two, and in the triclinic system all three are inclined to each other as well as being of unequal lengths. In the trigonal system the three crystal axes are parallel to the edges of the primary form, the rhombohedron, which may be regarded as a cube standing on one corner with a diagonal vertical, the cube being either compressed or extended along this diagonal direction, which is identical in direction with the singular trigonal axis of symmetry. It is also possible to use the hexagonal axes for the description of trigonal forms, and indeed, under the old methods of description, before the present truly scientific method of regarding axes and planes of symmetry as the only real criteria of symmetry, the trigonal classes were considered as "hemihedral" classes of the hexagonal system, that

is, hexagonal forms in which half the number of faces constituting the hexagonal classes were suppressed.

Now quartz crystallises, as already mentioned, in this particularly interesting trigonal system of symmetry. The holohedral class of the system, exhibiting the maximum degree of symmetry, possesses, in addition to the essential vertical axis of trigonal symmetry, three symmetry planes mutually inclined at 120° and intersecting in the trigonal axis, as well as an equatorial plane of symmetry horizontally arranged at right angles to the trigonal axis, and also three digonal axes of symmetry lying in the equatorial plane at its intersection with the three vertical symmetry planes. But quartz does not develop this full holohedral trigonal symmetry, but that of the trapezohedral class of the system, no plane of symmetry being present, and the three digonal axes occupying positions in the horizontal plane midway between those of the holohedral class. We may represent these elements of symmetry by the diagrams given for right- and left-handed quartz respectively in Figs. 2 and 3.

The trigonal axis perpendicular to the plane of the paper (the equatorial plane) is represented diagrammatically by the little equilateral triangle in the centre, the three digonal axes by the dotted diameters terminated by little ellipses, an equilateral triangle and an ellipse

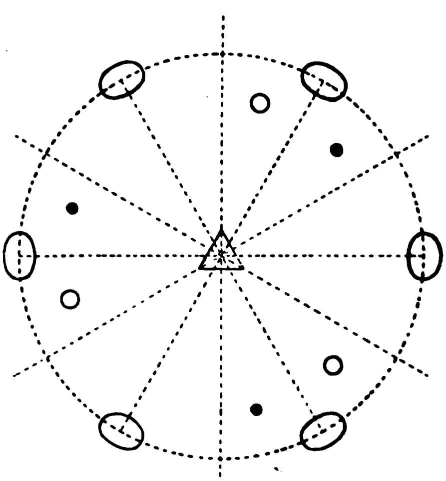

Fig. 2.—Elements of Symmetry of Right-handed Quartz.

being the symbols introduced by Gadolin for the ready indication of a trigonal and a digonal axis of symmetry respectively. And this leads us to the consideration of a most convenient mode of drawing a plan of the crystal faces. For we may imagine each of the diagrams in Figs. 2 and 3 to be the projection of a sphere on its equatorial plane, the eye being supposed to

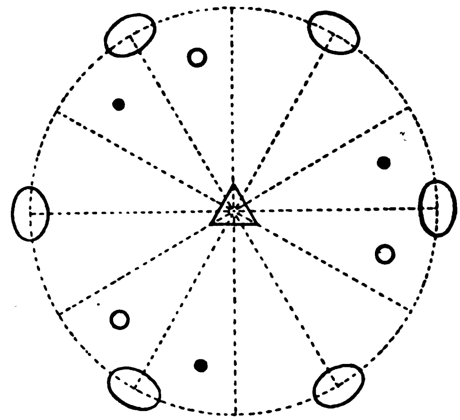

Fig. 3.—Complementary Figure for Left-handed Quartz.

be situated at the pole; and we may then adopt the exceedingly useful convention of employing such a spherical, or more correctly stereographic, projection as our plan displaying the distribution of the faces and the symmetry of the crystal in an obvious and interesting manner. We imagine the crystal to be placed at the centre of the sphere, and that normals are drawn to all the faces or their planes produced, from the centre of the sphere, and the points where these normals cut the surface of the sphere are considered as points or "facial poles" representative of the faces. If, then, we take the solid dot near the front of Fig. 2 and to the right of the back-to-front diameter as such a facial pole of a face of most general character, inclined to both the vertical trigonal axis and to the horizontal digonal axes, then it will be obvious that the operation of the trigonal axis, rotation for 120°, will require two other facial poles to be present, similarly placed with respect to the three digonal axes and at 120° from each other in the diagram. Also the operation of each of the digonal axes, rotation for 180°, will require the presence of a second facial pole, represented by a little ring instead of a dot, at an equal distance on the other side of that axis, and representing a face in the lower hemisphere. Now these six faces thus required to be present by the symmetry elements in operation, when one such face is given as present, make up a double trigonal pyramid of which the lower half is rotated somewhat with respect to the upper, screw-wise, and the solid thus produced is

known as a trigonal trapezohedron. The one corresponding to Fig. 2 is represented in Fig. 4.

But there is no more reason why we should have started with a dot-pole to the right of the

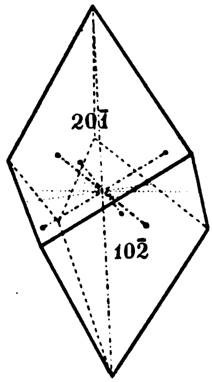

FIG. 4.—RIGHT TRIGONAL TRAPEZOHEDRON.

back-to-front diameter of Fig. 2 than with one to the left of the latter, and the similar diagram drawn on that assumption is shown in Fig. 3, and the solid which it represents, complementary to that shown in Fig. 4, is given in Fig. 5. Now it will be at once apparent that Figs. 2 and 3, and also Figs. 4 and 5, are the mirror-images or reflection-complements of each other. This means in actual fact that two trigonal trapezohedra, which are the mirror-images of each other, are possible, and the two solids are quite distinct, for no amount of rotation will bring either to resemble the other. That of Fig. 4 is called the right trigonal trapezohedron, and that of Fig. 5 the left variety. This fundamental fact

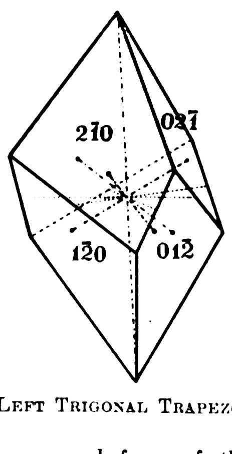

FIG. 5.—LEFT TRIGONAL TRAPEZOHEDRON.

respecting the general form of this class of trigonal symmetry affords the explanation of the two varieties, right and left-handed, of quartz, which mineral shows characteristic development, in the well-known little x faces, of the two trapezohedra. Indeed, so fundamental is the fact that this class of trigonal symmetry is currently known both as the trapezohedral class and the quartz class.

Two characteristic crystals of quartz, a left-handed and a right-handed one, are shown in Figs. 6 and 7, on which the small faces x are those of the left and right trigonal trapezohedra respectively. Also, the little adjoining faces s are those of another pair of mirror-image complementary and quite distinct forms of the trapezohedral class of trigonal symmetry, the left and right trigonal bipyramids. The other faces shown on Figs. 6 and 7 are those of the hexagonal prism m, which is a form common to both the hexagonal and trigonal systems, and which is also common to both varieties of crystals of the trigonal trapezohedral class; also those of the two complementary rhombohedra r and r', which together make up what appears

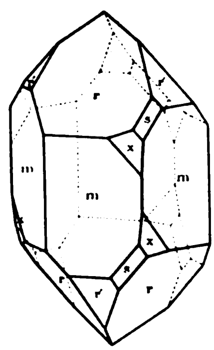

FIG. 6.—RIGHT-HANDED QUARTZ.

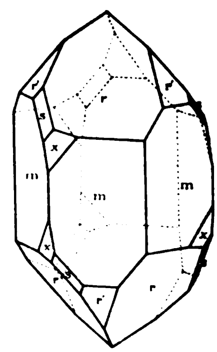

FIG. 7.—LEFT-HANDED QUARTZ.

to be the hexagonal pyramid terminating each end of a fully-developed quartz crystal. Alternate faces of the pyramid belong, however, to different rhombohedra, three to r and three to r', and they are often characteristically different, either in amount of development, or in polish, the faces of the rhombohedron r being much more brilliant than those of r'. Moreover, the quartz crystals from a particular locality in Ireland characteristically show one rhombohedron only, without a trace of the other.

It will be observed, further, that the little s and x faces occur replacing left solid angles on a left-handed crystal, and right solid angles on a right-handed crystal. Also, if x faces be absent, a good little s face is often present, and it is usually marked by striæ parallel to the edge sr, which enable the location of the face, and its nature, to be recognised.

THE INTERNATIONAL ELECTROTECHNICAL COMMISSION.

REPORT OF THE FOURTH MEETING, HELD IN TURIN FROM SEPTEMBER 7TH-11TH, 1911.

The fourth meeting of the International Electrotechnical Commission was held in Turin last month, coming to a close on September 11th.

The work of the Commission has steadily grown in importance during the last few years, and the meeting that has just terminated was considered one of the most successful yet held. The need for such a supreme international authority on electrical matters had made itself evident. The relations between engineers and firms concerned with electrical goods in different countries make it essential that there should be some common understanding regarding the rating of machinery and terms and symbols used. The Commission has already been signally successful in rendering assistance in this direction, and year by year has gained additional support. At the last meeting no less than twenty-one different countries were represented, and this led one of those present to refer to the gathering as "The World's Future Electrotechnical Parliament."

The opening ceremony and subsequent meeting took place in the Palazzo della Prefettura, where an impressive address of welcome on behalf of the Italian Government was delivered by His Excellency the Minister of Posts and Telegraphs, Signor Avv. T. Calissano. The proceedings were formally opened by Colonel R. E. Crompton; and Professor Elihu Thomson, the honorary President, who had travelled specially from Boston to attend this meeting, delivered a most interesting and inspiring address.

"To us members of the Electrotechnical Commission," he said, "gathered together under the canopy of the glorious Italian sky, historical memories are bound to occur. When the people of the Orient, reduced to impotence by their overwhelming riches, allowed the world's sceptre to slip from their enfeebled grasp, it was here in Rome that it was again raised aloft. The civilisation of the Latin races developed to so high a degree, that even to-day the most advanced nations are glad to take advantage of it. And when, in its turn, the great Roman Empire fell before the hoards of Barbary, when intestine wars and medieval invasions decimating Italy seemed once more to arrest the march of civilisation, the torch of the Latin races, far from being quenched, burst anew into brilliant flame. Such names as St. Thomas Aquinas, Dante, Michael Angelo, Galileo, and Leonardi da Vinci, witness the fact that in Art, as in Science and Philosophy, Italian genius has been able to produce men before whom the centuries to come will pay homage even to the end of time.

"Coming now to the field of science which is the real reason for our assembling here to-day, we remember those pioneers Galvani and Volta, to whose genius and ability the first practical development of electrotechnics is due. Fifty years later Antonio Pacinotti gave us the principle of the dynamo electric machine for continuous currents. Later Galileo Ferraris discovered and gave to science the revolving field, which has enabled polyphase currents to be made use of with such success."

Proceeding, Professor Thomson alluded to the development of wireless telegraphy, with which the name of Signor Marconi will always be associated. It was befitting, he said, that, at this celebration of fifty years of national unity, Italy should hold an international exhibition, which would serve as a centre for several congresses and illustrate both the advances in electrical science and its influence on the commercial development and prosperity of nations.

Professor Thomson also dwelt upon the fact that much of the work so far carried out had served to pave the way for future efforts. It was necessary to proceed with caution, because conditions of the electrical industry were constantly changing, and it was not desired to retard the progress by trying to standardise matters which were in a constant state of change. The Commission, however, was alive to the importance of conducting its work in such a way as to avoid anything of this nature, and to be of permanent assistance to the electrical industry.

The variety of subjects which the Commission had to deal with was very great, and it was therefore desirable that similar international committees should be appointed to report to the central office on their respective subjects. This suggestion afterwards received the approval of the Congress, and three sectional committees of this kind have been formed.

One subject on which there was a special need for agreement was the nomenclature and terms used in illuminating engineering. It was common knowledge that the expressions of methods in different countries differed considerably,

and it would be advisable for the Electrotechnical Committee to co-operate with the illuminating engineering societies in Europe and America when dealing with these points. In passing, he welcomed, on behalf of the Commission, the presence of Mr. Leon Gaster, the hon. Secretary of the Illuminating Engineering Society of London, who had been specially invited to attend this gathering, and laid stress on the important international organisation of the society which he represented.

Colonel R. E. Crompton, hon. Secretary of the Commission, gave a brief description of the work undertaken since its formation less than four years ago. He recalled that in 1908 there were only ten countries participating, whereas local electrotechnical committees in no less than wenty-one countries have now been appointed, and several other countries have since undertaken to do so. He also pointed out that the short biography of the life and work of their late President Mascart, so ably compiled by Professor Paul, had been very much appreciated, and suggested that the masterly brief biography of the late Lord Kelvin, written by Professor Silvanus Thompson, should be published in English and French at the expense of the Commission. This suggestion was adopted unanimously, and we may look forward to seeing this valuable addition to the publications of the Commission in print very shortly.

The official meeting took place on Monday, September 11th, and a number of important resolutions were passed unanimously. Many of these had to deal with the list of terms previously submitted, which were now adopted unanimously after a few slight modifications had been made in consultation with local committees in different countries.

Perhaps the most important resolution was that proposed by Dr. Budde and seconded by Mr. Alexander Siemens, regarding the symbols to be used to represent current, electromotive orce, and resistance respectively. It is a common experience of students of electrical engineering that the text-books in different countries have followed different methods of denoting these quantities, and much confusion and needless inconvenience have been the result. It has now been agreed that the list shall be the same in all countries, namely: I for current, E for electromotive force, R for resistance. In order to arrive at this desired result, concessions were made by several nations. Germany, for example, abandoned the letter W (Widerstand), hitherto used for resistance, and Great Britain C, previously used to denote current. This simplification should prove of great convenience, and we may hope that it may be followed in other directions.

Another matter on which valuable agreement was arrived at, was in connection with the graphical representation of alternating electric and magnetic quantities, it being resolved that in future advance in phase should be represented in the counter clockwise direction. This again is an important decision to students, for text-books in different countries have hitherto sometimes followed exactly the reverse convention, so that the same diagram might occur in two books with opposite meanings.

Other resolutions referred to the rating of electrical machinery and apparatus, the propositions of the previous unofficial Congress in Brussels, 1910, being adopted without modifications.

The necessity for studying the terms and symbols used in connection with illumination was pointed out by the hon. Secretary of the Illuminating Engineering Society of London, Mr. L. Gaster, who suggested that the various national committees should be requested to put themselves in touch with the societies in their respective countries dealing with these questions. The proposal received the support of Dr. A. E. Kennelly and Dr. Clayton Sharp, speaking as President and Past President respectively of the Illuminating Engineering Society in the United States, and the Commission unanimously accepted the propositions, and passed a resolution to co-operate with the illuminating engineering societies on these matters in the future.

The resolutions of the International Electrotechnical Commission will doubtless go far to pave the way for agreement among electrical institutions, and it may be hoped that a similar co-operation on the part of the gas institutions will be secured.

The question of future meetings of the Commission also came up for discussion, and it was decided, on the proposal of Professor L. Lombardi, seconded by Mr. Alexander Siemens, that the next official meeting should be held in Berlin in 1913.

Mr. Gano Dunn, President of the American Institution of Electrical Engineers, then offered a cordial invitation of that Institution for the subsequent official meeting to be held at San Franciso in 1915, on the occasion of the opening of the Panama Canal. Professor Feldmann, seconded by Mr. W. Duddell, expressed

the thanks of the Commission to Mr. Dunn for this invitation and its willingness to hold the official meeting in San Franciso as suggested. It was also resolved to instruct the central office to assist the American Institution of Electrical Engineers in promoting an international Electrical Congress to take place simultaneously with a meeting of the Commission.

It may be added that a most important resolution was subsequently passed at the meeting of the International Electrical Congress, which took place in Turin last month. The fact that the meetings of the Commission and the Congress were held at the same time and at the same place proved to be exceedingly convenient, and it may be hoped that the great success of the gathering in Turin will form a valuable and encouraging precedent. It was decided that the time and place of meetings of Congresses in future should be determined by the International Electrotechnical Commission, the organisation of the details of the meeting being entrusted to the local committee working in co-operation with various institutions concerned.

This decision to place the organisation of future International Congresses under the supervision of the International Electrotechnical Commission, which is a supreme administrative authority in electrical matters, has received very general approval.

In conclusion, it only remains to be noted that the proceedings of the International Electrotechnical Commission were most cordial throughout, and it is pleasant to see that whatever political differences may divide nations, their men of science recognise no geographical or other artificial barriers, and are willing and able to meet together and make concessions for the common weal. The election of the new President, Dr. E. Budde (the present President of the Verband Deutscher Elektrotechniker), was proposed by Mr. R. V. Picou, the President of the French Electrotechnical Committee, and carried with acclamation.

It may be added that the fact of the meeting being held in Turin this year was due to the courtesy of the German delegates, and especially of Professor Dr. Budde, the newly-elected president, in waiving their prior claim for the gathering to take place in Berlin. In this Dr. Budde received the able assistance and support of the untiring secretary of the Verband Deutscher Elektrotechniker, Herr G. Dettmar, and the Commission was also honoured by the presence of Geh. Ober Postrat Prof. Dr. D. K. Strecker, President of the Symbols Committee of the Elektrotechnischer Verein.

Among the official delegates of the different countries who were present on this occasion may be mentioned: Mr. Alexander Siemens, Professor Silvanus P. Thompson, and Major W. A. J. O'Meara (Great Britain), Mr. Gano Dunn (President of the American Institution of Electrical Engineers), Mr. C. O. Mailloux (U.S.A.), Dr. E. Budde (Germany), Mr. F. H. Mears (Government of India), MM. P. Boucherot, R. V. Picou, and F. Laporte (France), E. Gerrard and O. de Bast (Belgium), Professor L. W. Gill (Canada), Professor A. Larsen (Denmark), Don Luis de la Pena (Spain), Professor C. Feldmann (Holland), M. de Chatelain (Russia), Professor J. Landry (Switzerland), Mr. C. A. Rossander (Sweden), Mr. A. Costello (Mexico), Dr. A. Oya (Japan), Mr. J. Muller (Ecuador), etc.

Special mention should be made of the valuable services of Professor Luigi Lombardi, the President of the Italian Institution of Electrical Engineers, who kindly presided over the unofficial meetings; of Professor G. Grassi, and of Signor Guido Semenza of the Italian Local Committee; and, finally, acknowledgment is due to Colonel R. E. Crompton, the hon. Secretary of the Commission and its indefatigable general secretary, Mr. C. le Maistre, on whose shoulders much of the work of bringing the meeting to a successful issue has fallen.

ESTABLISHING A SOLAR OBSERVATORY IN AUSTRALIA.*

The movement has gained ground steadily during the past year, and it is evident from the support it has received that much more widespread sympathy has been accorded to it than could have been anticipated at the outset. In Australia, where there exists a Solar Physics Committee to co-operate with the British Association Committee to promote the proposed solar observatory, the movement has been once more the subject of a favourable resolution by the Council of the Australasian Association for the Advancement of Science, and public attention has been recalled to the subject by the expedition of British astronomers that passed through Australia *en route* for the

* Report of the Committee, consisting of Sir David Gill (Chairman), Dr. W. G. Duffield (Secretary), Dr. W. J. S. Lockyer, Mr. F. McClean, and Professors A. Schuster and H. H. Turner, presented to the Section of Mathematical and Physical Science of the British Association at Portsmouth, 1911.

solar eclipse at Vavau, in particular by Dr. Lockyer, a member of this Committee.

In England the desirability of Australian co-operation in solar research has been emphasised in several ways. Speaking at the Royal Society of Arts, the Permanent Secretary of the Commonwealth Office described Australia's eagerness to share in those pursuits of science in which she is best fitted to participate, and referred to the action taken by Mr. Deakin's Cabinet in offering the annual upkeep of this observatory, provided that £10,000 were forthcoming from private sources for its equipment. The British Empire League has accorded the proposal its hearty sympathy, and is now vigorously assisting the project by an active appeal to its members and sympathisers to support the movement.

It seemed opportune to take advantage of Mr. Fisher's presence in London to advance the observatory scheme, and a deputation was formed to wait upon him. The Royal Astronomical Society appointed the Astronomer-Royal, Sir David Gill, and Professor Newell to attend this deputation, the British Empire League being represented by Lord Avebury, and this Committee by the Chairman and Secretary. In the unavoidable absence of the Prime Minister of the Commonwealth at an extraordinary meeting of the Imperial Conference, the deputation was received by Mr. Batchelor, the Minister of External Affairs of the Commonwealth.

Sir David Gill, leading the deputation, referred to the gap in longitude which it is necessary to fill before the complete scheme of solar research can be effected, a gap which an Australian solar observatory would obviate, and pointed out her unique position south of the Equator. He mentioned the fact that the British Association had voted the sum of £50 towards the scheme, and asked on behalf of the Committee that the Australian Government would relieve him of the responsibility of this money by promoting the object for which it had been voted. He trusted that the work done by existing State observatories would not be interfered with by the establishment of a new observatory for the study of the sun.

The Astronomer-Royal referred to the excellent climatic conditions of Australia for solar observations. He pointed out the great theoretical value of a close study of the sun in its relation to the study of the physical conditions of the stars and of their development. He emphasised the importance of research work being carried on, because of its educational value, and expressed the view that the existence of a solar observatory would stimulate the study of physics generally as well as astrophysics in the universities of Australia.

Lord Avebury dwelt upon the unusual support that had been accorded to this scheme by learned societies, and suggested that such an observatory if established would ensure three of the four links in the chain of solar stations round the earth being within the British Empire, and all four—the British, Indian, Australian, and American—being conducted by English-speaking peoples.

Dr. Duffield referred to the progress of the movement in Australia, to the previous action of the Fisher Ministry in offering £1 for £1, to the vigorously supported public meeting in Melbourne, and to Mr. Deakin's promise of the upkeep provided £10,000 were privately subscribed. He further stated that over £4,000 had already been offered in money and apparatus, and that this was a sufficiently substantial sum to convince the Government that the people of Australia are in earnest in the matter. The press of Australia were unanimous in its favour.

The Minister, in reply, stated that he was impressed with the desirability of filling the gap in longitude, but that before action could be taken it would be necessary to consult the other members of the Cabinet. This would be done upon his return to Australia, and he personally promised to urge upon the Prime Minister and his colleagues the desirability of establishing a solar observatory in Australia.

THE ORIGIN AND PRODUCTION OF CORRUGATION OF TRAMWAY RAILS.*

The explanation of the presentation of this paper on a subject previously discussed in a brief paper by the author before the Association in 1907 is the fact that, although the serious increase of corrugation since that date has caused much trouble, expense, and public annoyance, the real cause of corrugation has not been recognised. One and the chief reason for this is the fact that corrugation can only be prevented by calling a halt in the direction in which tram-car design has increasingly tended in recent times. Great weight on small wheels at high speeds means a combination which is destructive to any permanent-way which, as a tramway or street railway, can be made with any known materials and used on the common highway. As an abstract of the paper which the author now offers, he cannot better present the salient points appealed to in his explanation of the causes and production of corrugation than by repeating them in the form previously outlined, and this he does with a full knowledge of the numerous writings and experiments on the subject and of inquiries by home and Continental bodies troubled by this engineering ailment.

Although the physical and mechanical conditions involved in the origin of corrugation are complex, the mode of operation of the causes is simple, and for an explanation simple phenomena of known recurrence and adaption in engineering works

* Abstract of a paper read by Mr. W. Worby Beaumont, M.Inst.C.E., before the Engineering Section of the British Association at Portsmouth, 1911.

may be appealed to. When a piece of cold iron or steel is subjected to pressure exceeding the limit of elastic compression by a rolling or hammering action, or by these combined, the result is spreading of the material and change of the dimensions. The hammering or rolling work done upon a surface tends to compress the material beneath it; but being nearly incompressible and unchangeable in density, the material flows, and change of form results.

Generally the material thus changed in form suffers permanently no greater stresses than those within its elastic limit of compression or extension. When, however, the material is not free to flow or change its form in the direction in which the stresses set up would act, the effect of continued work done on the surface is the growth of compressive stress exceeding elastic resistance.

In railway rails the freedom for the flow of the material is limited. Hardening of the surface takes place, and destructive compression of the surface material is set up. If the material be cast-iron the destructive compression causes crumbling of the superficies, and the consequent relief of the material immediately below from stress beyond that of elastic compression; but when the material is that of steel rails, crumbling is delayed by its greater elastic extensibility and toughness, the upper part near the surface being under intense compression, differentiating from a maximum at the surface.

The repeated running of the heavily laden tram-car wheel over the rail does thus gradually compress the surface of the crown of the rail. Of this stress transversely the material relieves itself partially by the detrusion at the edges of the rail, where it forms a lip on the outside or on the groove side, or on both. This lip remains on the outside of the rail, but is worn off on the inside by the wheel flange. In the longitudinal direction the stresses arising from the compression of the surface material are not thus relieved. The heavily laden tram-car wheel presses into the surface of the rail, and as it rolls along presses before it a wave of compression the translation of which involves the destructive rupture of the surface or the rise of the wheel over the minute crest of the wave. The result is the formation of an extremely hard surface in patches of various shapes and lengths, and separated by distances depending on several conditions, including the mechanical properties of the rail, its combined hardness and toughness. Where the bright hard patches alternate with an approach to regularity with the dull and rougher surface patches the result is known as corrugation. This character of surface may be found on every heavily worked tramway under conditions of such impartial contrariety that it may be ascribed to conditions of origin which are general.

The remedy appears to be: (1) Lighter cars; (2) larger wheels; (3) harder rails; (4) moderate speeds.

HOME INDUSTRIES.

Strikes and Wages.—It was remarked in these Notes a week or two ago that, although a strike may bring apparent advantage to the strikers—as in the recent disturbances at Cardiff—the victory may really spell loss to the winners, and the remark was illustrated by owners having largely ceased to sign on crews at Cardiff. This apparent gain but real loss is shown in another way by the action of a shipping company noted for its liberal treatment of its employees. As a result of the recent strikes, says *Fair Play*, this company gave an advance in wages ranging from 1*s.* to 3*s.* per day, while the seamen and firemen also secured large increases. Previously the company had always behaved very generously towards their men, and when the ships were in port, instead of discharging the seamen and firemen, found work for them and kept them on at day wages. Under the new arrangement they decided to have done with the men at the end of each voyage and to re-engage them when required, which would be just prior to the sailing of the vessels. They also employed in the different gangs for coaling, etc., more men than were necessary. Now the whole question of the employment of these men has been reconsidered, and only sufficient men are being taken on to do the work. And this is what is being very generally done. The employers consent, under pressure, to pay higher wages, but it is a grudging consent which leads them to overhaul expenditure in every direction, and to discard every consideration but that of legal liability, a change in the relations of masters and men that can hardly fail to deepen existing ill-feeling and industrial unrest.

The Minimum Wage.—There is grave reason to fear that the present acute unrest in the mining industry may spread from Wales to other parts of the country within the next few weeks, to the enormous loss of all directly concerned, that is to say, to a very much larger portion of the community than is generally supposed. Speaking at the annual meeting of the Bromhill Collieries last week, Lord Furness intimated that if the three-shift system is abolished the company will be unable to work its collieries, and they will be closed at once. The substitution at these collieries of two for three shifts would, if the managers' estimate is correct, entail a loss of from £30,000 to £40,000 per annum. Then, as to a minimum wage, the demand is for 2½ per cent. beyond present figures. This, as Lord Furness contends, cannot be paid unless the selling price is advanced. They pay an average of 7*s.* 5·85*d.* per day for every hewer, without taking into account the value of free rent and free fuel. If no man is to receive less than 7*s.*, and as much more as a good working place can give him, the hewing costs must increase largely, and the county average would probably reach 10*s.* for a day of seven hours. The result would be that prices in the home trade must rise accordingly, and the

export trade would be diminished. Meantime, the conference to consider the question of payment to coal-hewers for work done in abnormal places, which affects all the coal-mining districts in the Kingdom—though the trouble is much more acute in some districts than in others—has met and separated without coming to an agreement. The coalowners admit the principle of payment in abnormal places commensurate for the work done, but suggest that the matter is one for local settlement. The men call for a national settlement on the basis of the recognised minimum or average wage of the district, the setting up of machinery for the determination of all disputes as to abnormal places, and the payment of the average wage pending the settlement of the dispute. The difference between the proposals seems so small that one wonders at the failure to come to an agreement, and it is surely not too much to hope that a rupture will be avoided. Unfortunately a section of the men seem bent upon it.

Steamers and Boats.—The mishap to the "Olympic" has directed attention anew to the question of the adequacy of the boats on passenger ships and the machinery used to put them into the water. The launching of boats from a steamer so high out of the water as the "Olympic" is a difficult operation. As a rule, comparatively few deck hands are carried, and probably the "Olympic" has not more than sufficient to launch, say, four or five boats at a time. This points to the necessity for having boat-lowering gear that can not only be quickly worked but that can be worked by a small number of men. When a steamer is damaged by collision, and makes water, she naturally lists over on the side that is damaged, and if the list is at all heavy it makes it difficult, and sometimes impossible, for the boats to be swung out on the opposite side. It is, therefore, important that they should be swung out promptly before a serious list has developed. This truth has been recognised and acted upon by the South-Eastern and Chatham Railway Company on their boats running between England and France. The davits are those of Captain Petts, and are so constructed that by simply turning a handle fitted to the davit (and this could be done by the smallest of the steward's boys) a boat can be swung out ready for lowering in less than a minute no matter what angle the steamer is lying at. The davit is simple and always ready for use, and it is a little surprising, and indeed disconcerting, that other Channel steamers are allowed to carry large numbers of passengers although provided only with davits that are almost unworkable, and with boat-lowering gear quite unequal to the requirements of emergency.

Iron Ore from Russia.—It is understood that the Russian Government have it in contemplation to prohibit the exportation of iron ore by sea. For some time past its exportation over the western frontier has been prohibited. England, Germany, and Austria are the principal consumers, so that the measure is of interest to this country. The bill, if passed, will chiefly affect the Kriowoi-Roger and Donetz districts, the exports from which pass almost entirely through the port of Nicolaieff. They have been steadily increasing for some years past; exports of iron ore from the Donetz basin amounted to 26·7 million poods for the first five months of 1911, against 24 million poods for the corresponding period last year, and the Russian iron manufacturers during the same period took 97·8 million poods, against 84·5 million poods. It is estimated that the Kriowoi-Roger deposits of iron ore, which occur chiefly on the borders of the Ekaterinoslav and Cherson Governments, amount to about 5,250 million poods, representing 3,250 million poods of iron, whilst the total iron ore deposits in the country are about 50,000 million poods. The present export of iron ore from Russia would have to be very largely increased before it could have any very appreciable effect upon the ore deposits of the country.

A New Bleaching Process.—A new bleaching process has just been patented in Germany which dispenses with the use of ordinary bleaching powder solutions. The rights have been purchased by a new company, the Air Bleaching Company, Eilenburg, Germany, who will grant licences to those wishing to adopt it. The capital of the undertaking, the Luftbleiche, G.m.b.H., is 100,000 marks. The cloth is packed in the kier, which is specially arranged so that the goods are completely covered with the alkaline solution during the whole operation, a small quantity of manganese sulphate being added to the ordinary caustic soda solution. The goods are boiled about a couple of hours without the admission of air, and then a stream of air is forced into the kier under a pressure of about 3½ atmospheres, or 1½ atmospheres above the steam pressure. It is said that after further boiling twelve hours, air being forced into the kier during the whole time, the goods are completely bleached, no subsequent "chemicking" being necessary. A considerable saving in time and drugs is claimed.

Aluminium.—Aluminium prices have now fallen to a point at which manufacturers cannot sell at a profit. The explanation is, of course, over-production, and as the attempts to form an aluminium syndicate have been abandoned it is not likely that there will be much improvement for some time. At the beginning of the year the price to German consumers was about £70 per ton, during the past month it has been considerably under £60, and large quantities are said to be obtainable at about £52 per ton. Prices on the London Metal Exchange have been as low as £51 and £53 per ton. At these quotations aluminium is cheaper than copper, and electrical companies are contracting for large supplies. The cost of producing aluminium varies with each company, but it is pretty safe to say that at anything under £55 per ton it cannot be sold without actual loss to the manufacturers.

The Brooklands Agreement.—The weakness of the Brooklands Agreement was in its failure to provide for a renewal of negotiations once a strike has begun. Amendments have now been made, with the unanimous consent of the representatives of both employers and workmen, which repair this flaw. It is provided that when a strike has begun the negotiations shall be automatically renewed in the same place in which they were broken off. The first of such meetings is to be held within a fortnight after the strike has begun, and they are to be continued, at intervals of not more than a month, so long as it lasts.

The Agricultural Returns. — The preliminary statement of the Agricultural Returns shows a further reduction by 51,272 acres of the cultivated area of Great Britain, arable land having decreased by 20,986 acres, and permanent pastures by 30,456 acres. The acreage of wheat increased by 97,189 acres, and reached a total of 1,906,043 acres, being a larger area than has been recorded in any year since 1898. The acreage of barley declined 130,734 acres, a smaller total than any previously recorded. There is some indication of a revival in the cultivation of flax, which forty years ago occupied about 20,000 acres, but in recent years has almost disappeared. It is noticeable too, that the acreage of hops, for the second successive year, shows a slight extension, though it is still nearly 12,000 acres less than it was so recently as 1907. The acreage under fruit is stationary.

CORRESPONDENCE.

THE ETYMOLOGY OF NATRON.

With reference to the footnote by Sir Henry Trueman Wood on natron in his most interesting and acceptable paper on "The Royal Society of Arts," Part IV., in our *Journal* of the 29th ult., I should like to add the following remarks to his own on the etymological point raised by him.

"Natron," through Latin "natrum," and Greek *νίτρον*, is ultimately from the Hebrew *nether;* the word used by the Jews to distinguish mineral *alkalis* [Hebrew *Kalah* "to burn," and Arabic *al-Kala*, "the burnt"] in general, from vegetable alkalis, or *borith*. In Proverbs xxv. 20, where the word is translated in the English Authorised Version of the Bible:—"As vinegar upon nitre, so is he that singeth songs to an heavy heart"; and, again, in Jeremiah ii. 22:—"Though thou wash thee with nitre, and take thee much sope, yet thine iniquity is marked before me," obviously "natron," or "neutral carbonate of soda," is meant and not nitre [French form of nitrum]. The *νίτρον* of Herodotus ii. 86, is also undoubtedly our natron. But Pliny, following Theophrastus and others, certainly includes various alkalis under the term. Thus, xix. 26 (5), he tells us that the *Egyts* of Ancient Egypt used "nitrum" to water radishes—"in Ægypto nitro sparguntur"—so famous for the mildness of their flavour. This reads more like nitre, or "nitrate of potash." Then, in xxxi. 46 (10), he writes:—"nitrum closely resembles salt"—"natri natura non multum a sale distans"; which reads more like nitre than soda. Virgil, "Georgics," i. 94, states that the Roman cultivators soaked almonds before sowing them in nitrum and lees of olive oil, that they might bear the larger fruit:—

"Semina vidi equidem multos medicare serentes,
Et nitro prius, et nigrâ perfundere amurca,
Grandior ut fetus siliquis fallacibus esset."

Here "nitrum" might have been "natron." In China to this day, nitre, or saltpetre, and natron are confounded together. Natron is found over all the volcanic areas of India, the "dhobees-earth," used everywhere in that country for washing the clothes of Europeans, being but a crude natural form of nitron, combined with a proportion of muriate of soda. Natron also is largely yielded by "Lake Lunar," the dowsed crater [76° 30′ E. longitude, and 20° N. latitude] whence were poured forth the trappean streams that built up the greater part of the Western and Northern Deccan—the Deccan as distinguished from the Carnatic—when as yet it was still a triangular island, separated from the continent of Asia by the strait now represented by the valleys of the Ganges and the Indus. GEORGE BIRDWOOD.

October 2nd, 1911.

SLAG AND FURNACE REFUSE ORNAMENTS.

Not many years ago a great number of small useful articles were on sale in London, said to be made of slag or furnace refuse, in pretty imitation of onyx and malachite.

Can any member say whether such things can now be bought, and if so, where?

The articles coming under the writer's notice were ash-trays, pin-trays, candlesticks, trinket boxes, inkstands, etc., and were brittle. It would be interesting to learn something of the process of manufacture, and particularly where they were made, and why the general supply in this country ceased. JOHN RYLE.

Brighton.

GENERAL NOTES.

LECTURES ON ILLUMINATING ENGINEERING.—A special course of twelve lectures on Illuminating Engineering, under the direction of Mr. L. Gaster, editor of *The Illuminating Engineer*, will be delivered by Professor J. T. Morris, Mr. J. G. Clark, Mr. E. Scott-Snell, Dr. W. J. Ettles, and Mr. J. S. Dow, at the Polytechnic, Regent Street, on Tuesday evenings, beginning on October 31st, 1911, and on Thursday evenings, beginning on January 11th, 1912. The course will deal with all illuminants,

including electric, gas, oil, and acetylene lighting, the effect of light on the eye, and the hygienic aspects of illumination, the measurement of light and illumination, etc. Practical problems, such as the lighting of schools, streets, factories, etc., will also be treated, and the lectures will be fully illustrated by lantern-slides and demonstrations. A similar course will also be delivered during the coming session at the Battersea Polytechnic.

THE NUMBER OF BICYCLES IN FRANCE.—In 1910 the number of bicycles in France exceeded 2,700,000, and produced a revenue of about 8½ millions of francs (£340,000). The departments having the greatest number were those of the Seine, with 287,422; Nord, 146,449; Seine-et-Oise, 87,539; Pas de Calais, 65,225; Gironde, 64,889; Seine Inférieure, 57,243; Maine-et-Loire, 53,855; Seine-et-Loire, 52,619; Seine-et-Marne, 52,488; Loiret, 50,310. The department with the smallest number was that of Lozère, with only 2,394 cycles.

FOREIGN TRADE OF GERMANY.—The exports and imports of Germany during the first six months of the present year as compared with those of the corresponding six months of 1910 are given in thousand of marks as follows:—

	1910.	1911.	Increase.
Exports . . .	3,646,200	3,847,900	201,700
Imports . . .	4,613,400	4,771,800	158,400
Totals . .	8,259,600	8,619,700	360,100
£ sterling .	£412,980,000	£430,985,000	£18,005,000

The value of the imports in 1911 exceeded that of the exports by 923,900,000 marks (£46,195,000), as compared with 967,200,000 marks (£48,360,000) of the previous year.

IMPORTS OF ARTIFICIAL FLOWERS TO ITALY.—According to the *Bulletin de la Chambre de Commerce française* of Milan, the importation of artificial flowers to Italy is increasing. In 1910 the quantity of these goods imported by that country amounted to 26,259 kilogs. (57,901 lbs.), of which 13,656 kilogs. (30,113 lbs.) were from Germany; 9,805 kilogs. (21,620 lbs.) from France, and the remainder, 2,798 kilogs. (6,168 lbs.) from other countries.

INTERNATIONAL CONGRESS FOR THE OIL INDUSTRY.—An International Congress, under the honorary presidency of the Minister of Agriculture, organised by the Société Nationale d'Oléiculture de France, will be held at Avignon from November 14th to 17th next. The principal subjects to be discussed, on which papers will be read by some of the most eminent French and Italian authorities, will be on the extinction of such pests as the olive fly, the phéothrips, and other parasites which have played such havoc of late years in the olive-growing districts, especially in France and Italy. Interesting papers are also announced on new methods for the extraction and purification of oil from the olive, as well as the results of a new process of extraction of oil in the vacuum (Système Acapuleo), which has been carried out by Professor Mingioli of the Agricultural School of Portici, Naples, for the Italian Government. Excursions will be made to places of interest in the neighbourhood as well as visits to some of the best managed olive estates and oil works, where many of the best known brands of oil are manufactured. Members of the Congress will be entitled to a reduction of 50 per cent. on all railway fares, and to special terms at the principal hotels at Avignon.

THE WINE AND OIL PRODUCTION OF TURKEY.—The production of wine is a growing industry in Turkey, especially in Syria, Palestine, and the Smyrna and Salonica districts. It is estimated that in 1910 the output aggregated some 100,000 tons, most of which was consumed in Turkey and Egypt. Europe (especially Germany and France) and America, however, buy increasing quantities of Turkish wines, both red and white. Wine, next to mother-of-pearl articles, constitutes the principal item of export to the United States from Jerusalem. It is estimated that out of a production of 60,000 tons of olive oil, which is a fair average estimate for Smyrna and the adjoining islands, 15,000 tons are exported, another 15,000 tons absorbed by the Turkish soap industry, and the remainder consumed by the inhabitants, who, in consequence of the increased cost of olive oil, are gradually forced to adopt substitutes (animal fats, etc.) from abroad. Under normal conditions the cost of edible olive oil averages about fivepence per pound, and the total output in the Ottoman Empire amounts to about 75,000 tons. There is a tendency in Turkey now to produce higher grade oil, fit for European and American tables, and this is particularly noticeable in Aivali, Mitylene and Crete.

MEXICAN "COMITECA" LIQUOR.—"Comiteca" is the name given to a spirituous liquor manufactured in Comitan, State of Chiapas, Mexico. It is an exclusively local product, since in no other part of the country is anything similar produced. The species of maguey, or agave, from which it is distilled, thrives only within a radius of ten or twelve miles, outside of which the agave plants have, it is true, certain alcoholic properties, but in comparison are little adapted to the distillation of this class of liquor. Its specific qualities are known only in a few states of the Republic and in Guatemala, as yet the only foreign market in which it has been introduced, owing to the lack of proper means of transport. The liquor is distilled from "pulque," a beverage brewed from the sap of the maguey. To pulque is added a certain proportion of "panacha" (coarse dark sugar), then, for the sake of the tannin, the inner bark of a species of oak, styled in the native Indian dialect "pajulul," and last, distilled water. It is the maguey plant from which the liquor is extracted which gives to the "cometica" the especial flavour and aroma.

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FRIDAY, OCTOBER 13, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

ROCK CRYSTAL: ITS STRUCTURE AND USES.

By ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S.

Lecture II.—Delivered May 8th, 1911.

In order to emphasise the facts referred to in the first lecture concerning the exterior configuration of quartz, we cannot do better than take a characteristic well-formed crystal and measure it on the goniometer, which will bring home the arrangement of the faces in a manner which nothing else could. Such a crystal, actually measured in great detail by the author, is shown in Fig. 8 and its stereographic projection, the plan of its faces, in Fig. 9.

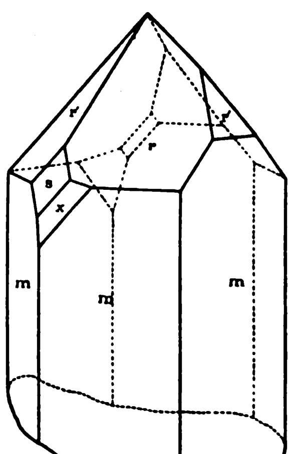

FIG. 8.—MEASURED CRYSTAL OF QUARTZ.

The reflecting goniometer, the principal instrument of the crystallographer's laboratory, consists essentially of an accurately-divided circle, reading with a vernier to single minutes of arc, and which can be made to carry the crystal on its axis of rotation. The crystal is not directly mounted on the central axis, but on a little cone of wax carried at the summit of a series of centring and adjusting movements, the latter consisting of two circular movements at right angles to each other, so that the crystal, which should be very small, the size of small shot or a small pea being suitable, may be brought exactly into the axis of rotation of the circle and adjusted so that the edge between any given pair of faces is parallel to the axis. A collimator, provided with a slit of the kind first recommended by Websky, narrow in its central part for adjustment to the vertical cross-wire of the telescope and broad at the two ends in order to render it more readily visible, is arranged on one side of the circle, and a telescope on the other, both pointing to the axis of rotation and perpendicular thereto, while being parallel to the circle. Reflections of the Websky slit are then arranged by adjustment of the crystal to be afforded in succession from the two faces in question, between which it is

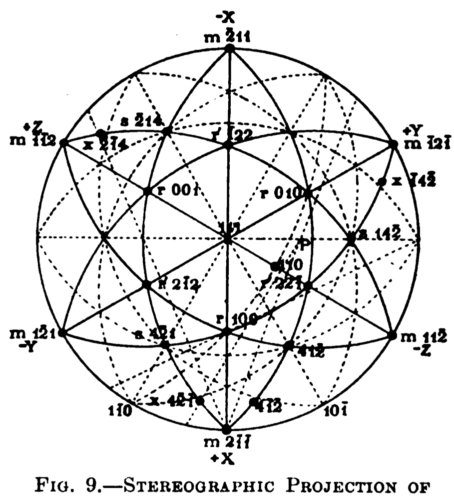

FIG. 9.—STEREOGRAPHIC PROJECTION OF QUARTZ CRYSTAL.

desired to measure the angle, by rotation of the circle with the crystal axis, the telescope and collimator being fixed at some convenient angle, about 120°, for obtaining the reflections. The image of the slit from each of the two faces is then brought in succession to the cross-wires of the telescope, by rotation of the circle (and thereby of the axis and crystal), a reading of the circle being then taken for each position; the angular difference between the two readings is the supplement of the dihedral angle between the two faces, and is the angle between the normals to the two faces, the actual angle marked on the stereographic projection. This will all be clear from Fig. 10, in which *T* is the telescope, *C* the collimator, and *a*, *b*, *c* the crystal, relatively grossly exaggerated in size for the sake of clearness, the face *b* of which is adjusted to give a

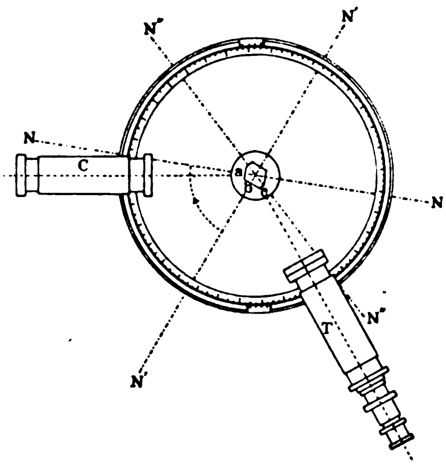

FIG. 10.—DIAGRAM ILLUSTRATING THE PRINCIPLE OF THE GONIOMETER.

reflection of the collimator slit in the telescope. *N′N′* is the normal to the face *b*, while *NN* is the normal to the face *a*, and *N″N″* that to the face *c*. In order to bring the face *a* to give a reflection, for instance, supposing the edge *ab* (the crystal edge between the two faces *a* and *b*) to have been adjusted parallel to the axis of the goniometer, it would be necessary to rotate the crystal through the angle on the left between *NN* and *N′N′*, the angle marked by an arc. The little arrow on the arc indicates the direction of rotation when the angle *ab* is being actually measured, the face *a* being first adjusted as *b* is shown to be in the figure, and the axis rotated until *b* is so adjusted, as shown.

It is much more convenient for the crystallographer to record these angles between the normals to the faces, rather than the dihedral supplements, because he is sure to want to construct a stereographic projection, and it is precisely the positions of these normals with respect to the sphere, the centre of which is supposed also to be that of the crystal as well as the sphere, which are required, the intersections of the normals with the spherical surface being the facial poles, marking the positions of the faces on the projection.

The above facts can now be clearly illustrated by means of our little quartz crystal, Fig. 8, the measurement of the angles of which, and the construction of its stereographic projection, we are going to imagine we are carrying out together.

We will tackle first the obviously hexagonal prismatic zone of faces marked *m* in Fig. 8. The process of adjusting the edge and obtaining reflections of the Websky slit can be grossly demonstrated by a large crystal of quartz, some six inches long, of similar character, the image of a Websky slit placed in front of the electric lantern being reflected from each face in turn on to the screen.

The first thing that strikes us is that not only are these two particular faces adjusted by the adjustment of the edge between them, but that the whole "zone" of six faces of the hexagonal prism are so adjusted, the six faces being all parallel to the vertical axis. The actual angles on our little crystal proved to be 60° within a very few minutes, 8′ being the maximum difference from 60° 0′ in the case of the poorest face, while three of the more perfect faces gave values only differing by a single minute. Hence, there is no doubt whatever that nature intended the zone of faces to be a truly hexagonal one, of exactly 60° 0′ angle. We can, therefore, set out our bounding or "primitive" circle of the stereographic projection, and place dots on it for facial poles at 60° apart.

We may next conveniently measure the angle *mr* between the front *m* and top *r* faces, and on adjusting the edge *mr* parallel to the goniometer axis we find that not only are these two faces *m* and *r* adjusted, but also the parallel face *m* behind the crystal and the smaller pyramidal (rhombohedral) face *r′*. Moreover, the front and back angles *mr* and *mr′* prove to be both 38° 13′, the angle between *r* and *r′* being 103° 34′. We may, therefore, draw a diameter from back to front of the primitive circle in Fig. 9, to represent this zone, and mark on it the two poles *r* and *r′* at their proper positions equidistant from the centre and from the *m* poles. A very simple construction (marking off the angle on the

primitive circle instead of the diameter, and joining the marked-off point to the pole of the other hemisphere, the line of junction cutting the diameter at the facial pole required) enables this to be done on the drawing at once. Similarly, if we measure the angles between other *m* and *r* and *m* and *r′* faces along the two other such zones, represented in Fig. 9 by the two other diameters drawn in strong lines, we find that the angles are always 38° 13′ for *mr* or *mr′* and 103° 34′ for *rr′*, the greatest divergence owing to slight facial distortion never exceeding 6′ in the case of our actual little quartz crystal.

We may now draw circular arcs through the *m* poles on any one diameter and the *r* and *r′* poles on the two other diameters, as shown in Fig. 9, and measure the angles along them, that is, between the actual *m* and *r′* faces belonging to these different cross-zones. When we do so, we discover a further important fact, namely, that the little *s* and *x* faces of the left trigonal pyramid and left trigonal trapezohedron (for our quartz crystal is a left-handed one) are situated in these cross-zones. Thus, to take a single example, when we measure the angle between the front *m* face and the top-front-left *r′* face we come across the images from the faces *x* and *s* which replace this left-hand corner of the crystal, in intermediate positions between the *m* and *r′* images. The actual angles were $mx = 12° 1'$, $xs = 25° 57'$, $sr' = 28° 54'$, altogether making up an angle *mr′* of 66° 52′. These angles are precisely those of the characteristic left trigonal pyramid $s = (4\bar{2}1)$ and trapezohedron $x = (42\bar{1})$ of quartz.

Our little crystal shows a second pair of these *s* and *x* faces on the left-back corner, but the third pair belonging to these two forms were not developed. No such right-handed forms are present at all, however, modifying right-hand top corners of the *m* faces, so that the crystal is clearly a left-handed one.

We have thus actually worked out the symmetry of quartz, and proved it to be trigonal trapezohedral, and that two distinct varieties are possible, a right-handed and a left-handed, our example having been one of the latter variety.

We have thus made perfectly clear to ourselves the external configuration of quartz, and are now attracted by the further problem of the unravelling of the internal structure which is the prime cause of this outward development. There are several very interesting modes of tackling this more difficult problem, the chief of which are the study of the action of solvents on the facial surfaces of the material of the crystal, the nature and shape of the minute internal cavities which the microscope reveals in such abundance, the indications of any cleavage which may be developed, the development of any electrical excitation on heating and cooling again, and, most important of all, the effect of the crystal structure on the passage of light waves through it in different directions.

Considering first the evidence afforded by cleavage, this is very emphatic, in spite of the fact that quartz cleaves with only the greatest difficulty, and then only with the formation of more or less imperfect cleavage surfaces, very different to the perfect ones, as good as the best crystal faces, of calcite. Indeed, this fact of the difficulty of provoking cleavage in quartz, and its rare occurrence naturally, enhances wonderfully the importance and use of the

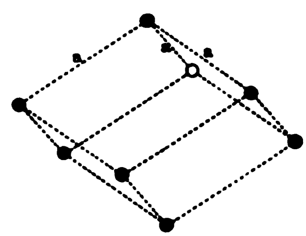

Fig. 11.—Unit Cell of Rhombohedral Space-Lattice.

mineral, both for scientific and industrial purposes; for it enables lenses, prisms, and plates of the mineral to be cut, ground, and polished with the greatest ease, without risk of flaw, and with a most satisfactory result as regards clear transparency and absence of defects. But when a quartz crystal is heated and then suddenly cooled by plunging it into cold water it breaks up into rhombohedra closely resembling cubes, the angle of which is 85° 46′, that of the primary rhombohedron *r* of Figs. 6 and 7. Now it is interesting also that simple apparent cubes, really these rhombohedra, of quartz are occasionally discovered, quite a number having been found in the neighbourhood of Bristol.

These facts afford not only most valuable confirmation of the trigonal as distinguished from possible hexagonal symmetry of quartz, but also indicate that the space-lattice structure present is that of the rhombohedron, the elementary cell of which is represented in Fig. 11.

Thus we conclude that if each molecule SiO_2 were represented by a point, the points would be arranged in the form of a rhombohedral

space-lattice having the angle of the rhombohedron of quartz, 85° 46′.

If we take the hexagonal section of a prism of quartz, and heat it gently and evenly over a small Bunsen flame or other source of heat, and then allow it to cool, electrical excitation is developed, positive and negative electricity being produced respectively at alternate corners of the hexagon. Now the three digonal axes of symmetry emerge at the six corners, and the little trigonal pyramid and trapezohedron faces *s* and *x* are present at alternate corners corresponding to one end only of each axis, and it is interesting that these corners where the little distinctive faces are present are those which become negatively electrified, while those corners where no *s* and *x* faces are developed become positively electrified. This disposition of the pyroelectric poles is precisely in accordance with the symmetry of the trapezohedral class of trigonal symmetry, and of no other, thus confirming our conclusions based on other considerations. These facts can be readily

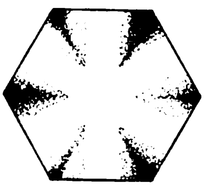

FIG. 12.—DISTRIBUTION OF SULPHUR AND RED-LEAD ON ELECTRIFIED HEXAGONAL PLATE OF QUARTZ.

verified by scattering a little of Kundt's powder, the well-known mixture of red-lead and sulphur, from a muslin bag over the hexagonal plate of quartz cut perpendicularly to the axis during cooling after the heating. On tapping the plate, the sulphur, which has become negatively electrified by friction with the muslin, will be attracted to the positively-electrified corners, while the red-lead, which becomes positively electrified, goes to the negatively-electrified corners. Fig. 12 will render this quite clear.

If we treat a pair of quartz crystals, right and left-handed respectively, with a small quantity of aqueous hydrofluoric acid, which is a chemical solvent for silica, characteristic little markings or "etch-figures," are produced on the faces. Fig. 13 shows the effect on a right-handed crystal, and Fig. 14 that with a left-handed one. The markings are little depressions, of the shape of a candle flame blown to one side by a draught of air, and are pointing upwards and downwards respectively on alternate faces. The etch-pits on the front *m*-face are turned somewhat to the right on a right-handed crystal and to the left on a left-handed crystal. Thus we have trigonal rather than hexagonal symmetry again demon-

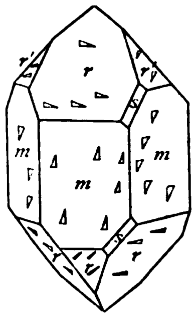

FIG. 13.—ETCH-FIGURES ON RIGHT-HANDED QUARTZ.

strated, and a screw structure, which may be either clockwise or anti-clockwise, such as corresponds to the trapezohedral class of the trigonal system, also most clearly indicated.

An interesting subject intimately connected with etch-figures is that of the shape of internal cavities in quartz. A remarkable example is shown reproduced in Fig. 15, which takes the form of a hexagonal prism capped by a pyramid, a kind of negative crystal of quartz. This cavity is filled, except for a bubble of water vapour, by a saturated solution of common salt, sodium chloride, from which a perfect little cube of salt has crystallised out. Such cavities are not at all uncommon in quartz, and are clear indications of the arrangement of the structural units, and a definite proof that the structure

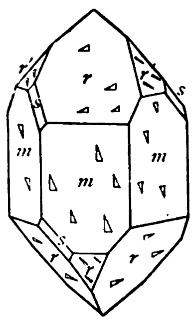

FIG. 14.—ETCH-FIGURES ON LEFT-HANDED QUARTZ.

developed at the exterior is the same throughout —that is, that the crystal is a homogeneous structure. The fluid contents are not always solutions of ordinary common salt, but of other well-known salts such as potassium chloride

and occasionally the liquid is compressed carbon dioxide, a fact which is proved by the disappearance of the bubble when the crystal is warmed to 32° C., the critical temperature of carbon dioxide, above which it is no longer capable of remaining liquid but becomes gaseous. Myriads of such small cavities occur in many quartz crystals, often in strings, and are clearly visible in the quartz crystals present in rock-sections, when examined under the microscope, and with a quarter-inch objective their shape may be readily studied. Those which take the form of negative crystals remind one of the hexagonal stars, or "water-flowers," produced in a slab of lake ice by the passage of the heat rays accompanying the beam of light from an electric lantern, and which make such pretty and instructive objects on the screen. Their explanation is probably

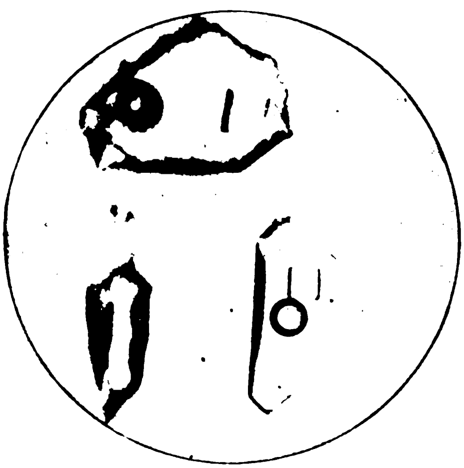

FIG. 15.—NEGATIVE-CRYSTAL CAVITY IN QUARTZ.

similar, namely, that the molecules of the substance, SiO_2 in the case of quartz, and H_2O in the case of ice, are taken down from their homogeneous structure in regular order, revealing the plan of construction of the crystal edifice.

It has thus been shown that the whole of the morphological characters of quartz, both those concerning the disposition of the exterior crystal faces and those directly concerning the internal structure such as cleavage, etch-figures, and the shape of internal cavities, all agree in pointing to a helical arrangement of the ultimate structural units, the chemical atoms of which the molecules of silica are composed.

We may now inquire, therefore, what evidence there exists as to the precise structure of quartz, beyond the fact already elucidated that the molecular structure, that is, the arrangement of the molecules considered as points, is that of the rhombohedral space-lattice. There is considerable evidence now accumulated, but in order to appreciate it reference must be made to two important advances which have been made in our knowledge of crystal structure in general, namely, the completion of definition of the possible types of homogeneous structures, of which there prove to be no less than 230, and the proof of the fixity of the positions of the atoms in the structure, and the allocation to them of definite portions of space, their spheres of influence.

It has already been indicated that the point or node of the space-lattice representing the molecule is, unless the substance be that of a chemical element, in reality the representative point (say centre of gravity) of a cluster of atoms, that which composes the chemical molecule. Now each atom of the cluster may be represented by a point, or it may be represented by its sphere of influence in such a manner that all the spheres of influence are in contact. Considering its representation by a point, Sohncke showed that there are sixty-five homogeneous arrangements of points conforming to the symmetry of the known classes of crystal symmetry. It was subsequently shown, however, by three other independent investigators, Schönflies in Germany, von Fedorow in Russia, and Barlow in England, that these sixty-five cases do not by any means exhaust the possibilities, and that, in fact, they do not account for all the thirty-two crystal classes. They pointed out that an important principle, that of mirror-image symmetry, had been left out of consideration, and that when this is introduced into the case 165 more types of homogeneous structures are possible, making 230 types in all, and that the whole of the thirty-two classes of symmetry are then accounted for, and no more than thirty-two are possible.

Speaking generally, therefore, it is the arrangement of the chemical molecules in a specific space-lattice which determines the crystal system, while the arrangement of the atoms in the molecule determines the details of the systematic symmetry, that is, the particular class. It is thus the stereometric arrangement of the atoms which gives rise to the ultimate symmetry, and the fact that the molecular clusters of atoms form a space-lattice has been liable to be overlooked. Indeed, the fact that the identification of the molecule in the crystal structure is geometrically unnecessary for a time so obscured the influence of the chemical molecule that the very existence of a molecular

directive force of crystallisation, that which brings the molecules together to form the crystal, was actually denied. But the researches of Lord Kelvin, Miers, Wulff, the lecturer, and particularly of Lehmann, who has introduced us to the marvellous phenomena of "liquid crystals"—substances more correctly described as mobile crystals, which may be as mobile as water and yet exhibit an outward form resembling that of a true crystal and the property of double refraction, and the molecules of which arrange themselves in space-lattices—have corrected this misconception. We now realise that although the atomic arrangement determines the detailed crystal structure, and many of the obvious optical properties such as rotation of the plane of polarisation, yet the underlying molecular space-lattice is none the less there.

Sommerfeldt has recently suggested that a model of the space-lattice is really alone necessary to portray the crystal structure, provided that at each of the nodes some device such as a little rod or bar be placed to indicate the kind of atomic arrangement, whether parallel, alternate, or otherwise orientated, as the mere space-lattice alone supposes that the node-points represent parallel-wise orientated units. That the space-lattice is fundamentally important is certain, and that the molecule is a distinct individuality, although in the solid crystal it loses its mobility, is equally now incontrovertible.

Reverting now to the second advance, it has been definitely proved by the lecturer that specific atoms of the molecule are definitely orientated in the crystal, and that if such atoms,

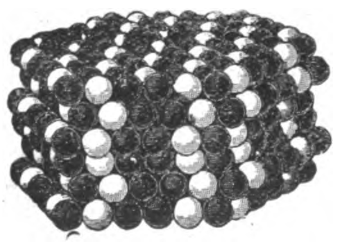

FIG. 16.—BARLOW'S CONCEPTION FOR RIGHT-HANDED QUARTZ.

say those of potassium or of sulphur in potassium sulphate, be replaced by others of the same family group of chemical elements, for instance, the potassium by rubidium or cæsium and the sulphur by selenium, specific directional changes in the crystal angles are observed to occur. In the cases just referred to, the replacement of the metal brings about an alteration in the length of the vertical axis of the rhombic crystal of the sulphate or selenate, while replacement of the sulphur by selenium causes an equatorial change. If, therefore, we accept the view of Barlow, and represent the atoms by their spheres of influence, we are only logically following up this important experimental fact.

Now, recently Barlow has propounded the view, in collaboration with Pope, that the relative size of the sphere of influence of the atom

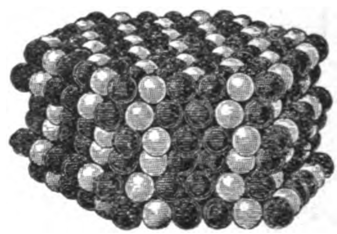

FIG. 17.—BARLOW'S CONCEPTION FOR LEFT-HANDED QUARTZ.

in any one compound, compared with that of any other atom in the same compound, is intimately connected with the chemical valency of the element, and that the dimensions of the sphere of influence are proportional to the fundamental valency. This "fudamental valency" is rarely the maximum valency, although in the case of carbon it would appear to be the latter, atomic spheres of influence of carbon having apparently four times the volume of those of hydrogen or chlorine present in the same compound. To us the cases of oxygen and silicon will at once appeal, and the relative size of the atomic sphere of influence of oxygen appears to conform to its usual dyad character. Silicon might, perhaps, from its occurrence in the same family group of elements as carbon, be expected to behave also as a tetrad, but there is much more evidence that its fundamental valency is only dyadic. Now Barlow has shown that if we accept the view that the fundamental valencies of both silicon and oxygen are dyadic, and therefore that the spheres of influence of the two elements in quartz are of the same size, the whole of the properties of quartz can be explained on the assumption that the two structures, right-handed and left-handed, are composed of such assemblages as are shown in Figs. 16 and 17, in which the white spheres represent silicon and the black ones oxygen atoms, there being two of the latter to every one of the former, corresponding to the formula SiO_2.

The helical character is clearly shown by these assemblages of silicon and oxygen atoms, the white spheres of the former being obviously

arranged in a right-handed screw in Fig. 16, and in a left-handed helix in Fig. 17, the two arrangements being the mirror-images of each other, as a right-hand glove is to a left-hand one. That some such structural arrangements of the chemical atoms as these are really present in the two varieties of quartz is, indeed, highly probable, and the optical properties of rock crystal, to be discussed and demonstrated in the next lecture, will be shown to lend strong confirmation to this view.

Before leaving this fascinating subject of the actual internal structure of a quartz crystal, it is interesting to recall that Lord Kelvin, in his Boyle lecture to the Oxford Junior Scientific Club in the year 1893, gave a remarkable geometrical conception of that structure. He said: "Make an equilateral equiangular hexagonal prism, with its diagonal from edge to edge ninety-five-hundredths of its length. Place a number of these close together, so as to make up a hexagonal plane layer with its sides perpendicular to the sides of the constituent hexagonal prisms. You see in each side of the hexagonal assemblage edges of the constituent prisms, and you see at each corner of the assemblage a face, not an edge, of one of the constituent prisms." (See Fig. 20 and imagine the little projecting or recessive semicircles absent and replaced by their diameters in continuation of the hexagons.) "Build up a hexagonal prismatic assemblage by placing layer after layer over it with the constituent prisms of each layer vertically over those in the layer below; and finish the assemblage with a six-sided pyramid by building, upon the upper end of the prism, layer after layer of diminishing hexagonal groups, each less by one circumferential row than the layer below it. You thus have a crystal of precisely the shape of a symmetrical specimen of rock crystal, with the faces of its terminal pyramid inclined at 38° 13′ to the faces of the prism from which they spring. But the assemblage thus constituted has senary (hexagonal) symmetry. To reduce this to ternary (trigonal) symmetry, cut a groove through the middle of each alternate face of the prismatic molecule, making this groove in the first place parallel to the edges; and add a corresponding projection, or fillet, to the middles of the other three faces, so that two of the cylinders similarly oriented would fit together, with the projecting fillet on one side of one of them entering the groove in the anti-corresponding side of the other. . . . We have then the three-pair anti-symmetry required for the piezo-electricity of quartz investigated so admirably by the brothers Curie, who found that a thin plate of quartz crystal, cut from any position perpendicular to a pair of faces of a symmetrical crystal, becomes positively electrified on one side and negatively on the other when pulled in a direction perpendicular to those faces. But this assemblage has not the chiral piezo-electric quality discovered theoretically by Voigt, and experimentally by himself and Riecke, nor the well-known optic chirality of quartz.

"Change now the directions of the grooves and fillets to either of the oblique configurations shown in Fig. 18, which may be termed right-handed because the directions of the projections are tangential to the threads of a three-thread right-handed screw, and Fig. 19, which may be called left-handed. The prisms with their grooves and fillets will still all fit together if they are all right-handed, or all left-handed. Fig. 20 shows the upper side of a hexagonal layer of an assemblage thus composed of the right-handed molecule of Fig. 18. A prism built up of

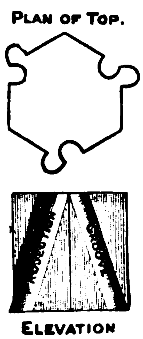

FIG. 18.—LORD KELVIN'S CONCEPTION FOR RIGHT-HANDED QUARTZ.

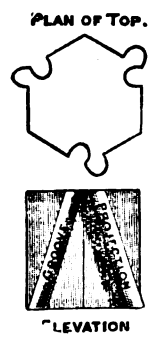

FIG. 19.—LORD KELVIN'S CONCEPTION FOR LEFT-HANDED QUARTZ.

such layers, and finished at each end with a pyramid according to the rules already referred to, has all the qualities of ternary (trigonal) chiral symmetry required for the piezo-electricity of quartz; for the orientational differences of the alternate pairs of prismatic faces; for the absolute difference between the alternate pairs of faces of each pyramid which are shown in the etching by hydrofluoric acid; for the merely orientational difference between the parallel faces of the two pyramids; and for the well-known chiro-optic property of quartz."

Lord Kelvin on the occasion of this lecture showed two beautiful models, one of a right-handed quartz crystal, built up of the right-handed constituent grooved and filleted hexagonal prisms of the character and

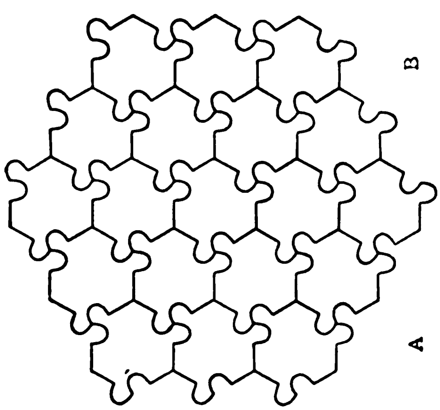

FIG. 20.—A RIGHT-HANDED LAYER OF LORD KELVIN'S ARRANGEMENT.

dimensions just stated, in accordance with Figs. 18 and 20, and another of the complementary left-handed character. The projecting fillets and retrogressive grooves may be taken as a gross geometrical device to indicate the helical arrangement of the elementary atoms, clusters of which corresponding to the chemical formula SiO_2 are built up on the plan of a trigonal space-lattice. Such helical arrangement of the atoms themselves is beautifully indicated in Barlow's conception of the arrangement of the spheres of atomic influence as shown in Figs. 16 and 17, and the author understands, from recent conference with Mr. Barlow, that further work on the subject has only more fully convinced him of the probability that these two arrangements of Figs. 16 and 17 do really represent the character of the internal structure of the two varieties of quartz.

NICE AS PORT OF CALL FOR OCEAN LINERS.

Although Nice can have no pretension to rival either Marseilles or Genoa as a commercial port, it is quite possible in the near future she may become a port of call for ocean liners.

Unlike Marseilles, with the valley of the Rhône and the centre of France at her back, or Genoa in direct communication by rail with Milan and Lombardy, as well as with Switzerland and Germany *via* the St. Gothard tunnel, Nice has no *hinterland* to support a large export or import trade. On the other hand, from her unrivalled position as Queen of the Riviera, she will always command a large and increasing passenger traffic.

Nice now numbers 168,000 inhabitants, and is 140 miles by rail from Marseilles and 115 miles from Genoa.

The actual port of Nice, or *Port Lympia*, is situated to the east of the "Chateau," in the old town. It consists of an outer and an inner harbour, covering an area of about fifteen acres of water. The length of the existing quays is about 650 metres (2,150 ft.). The entrance is protected from the south-west winds by a breakwater, and is well sheltered on other sides by hills and mountains. This port is only frequented by coasters and vessels drawing not more than 5·80 metres (19 ft.), and is of only local importance, and quite unsuitable as a port of call for liners.

This being the case, Nice may be considered as particularly fortunate in possessing, almost at her door—in Villefranche—a port suitable for vessels of large tonnage. Scarcely three miles from the railway station of Nice, the gulf of Villefranche, with deep water extending close in shore, is one of the finest natural harbours on the Mediterranean coast. It is much frequented by war vessels of all nationalities, the roadstead being well protected on three sides by hills and mountains, and affording excellent anchorage.

The growing importance of Villefranche as a port of call, may be gathered from the fact that, during last season, December 1st to March 31st, no fewer than twenty-four calls were made by ocean liners of 168,400 aggregate net tonnage, landing 1,051 and embarking 802 passengers and their luggage.

The landing was effected by means of a steam tender from the ship to a pontoon moored at the outer end of the mole or breakwater of the existing little port, which is situated at the north-west corner of the gulf.

Amongst the largest of these liners may be mentioned the "Cedric" and "Celtic" of 13,500 net tons each, and the "Arabic" of 10,000 net tons, belonging to the White Star line. The Cunard line was represented by the "Franconia" of 11,200 net tons (which called twice); the "Caronia," 9,000 tons (called once); the "Carmania," 10,000 tons (three times); and the "Saxonia," 9,800 tons (once). Of the other companies which used this port for landing and embarking passengers and a

small quantity of freight, may be mentioned the Peninsular and Oriental, the Hamburg-American line, the Fabre line of Marseilles, and the "Thelia," a steamer belonging to an Austrian line.

It is anticipated that no fewer than thirty liners belonging to various steamship companies will touch at this port during the coming season. Of these, 146,900 net tons will belong to ships of the White Star and the Hamburg American lines; while the tonnage of the vessels of the Cunard, Fabre, Peninsular and Oriental, and the Oriental Austrian Lloyds, will probably bring up the total to upwards of 250,000 net tons.

In order to provide further facilities for landing and embarking passengers, it will be necessary to extend the present mole or breakwater into deeper water, and so obviate the necessity of transhipment into a steam tender; to provide more ample accommodation for the examination of luggage by the Customs authorities than has existed hitherto, and to convey the passengers after landing rapidly to their destinations in Nice.

The local authorities are fully aware of this fact; and, thanks to the energy of the Mayor of Villefranche, M. Binon, the enlargement of the Quai de la Santé, close to the landing-place, is already well in hand. The new Custom House building, with commodious waiting and examination room, to be erected on the quay, has now been commenced. Ample space will be provided in front of the Custom House for fifty or sixty autobuses from the various hotels, to await the arrival of the passengers and to convey them to Nice in about half an hour.

Various projects for the construction of a deep-water harbour at Villefranche have been proposed. These schemes consist mainly in the construction of a breakwater 700 to 800 metres (about 2,300 to 2,600 ft.) in length, in a south-east direction, from the western shore, extending into a depth of water of about 25 metres (13½ fathoms) at its outer end. The entrance to the harbour would be about 200 metres (about 650 ft.) in width, with a depth of 20 metres (10¾ fathoms).

The extent of water thus enclosed would be well sheltered from the *Libeccio* (south-west) winds, whilst Monts Boron, Ferrat, and the Maritime Alps would afford complete shelter on the other sides.

The harbour thus formed would cover an area of 35 hectares (86½ acres) of water, with a depth, for the greater part, of more than 15 metres (about 8 fathoms). The quays would have an extension of 2,500 metres (about 8,200 feet run), with a depth alongside of 5½ fathoms.

One scheme includes a tunnel of about a mile in length under the Col de Villefranche, running parallel to the existing railway tunnel between Villefranche station and Nice, with branch lines and sidings to connect the port with a new goods station to be established in the suburb of St. Roch, on the left bank of the torrent Paillon. This part of the scheme would certainly not be required for many years to come, and not until the export and import trade of the port rendered the expenditure advisable.

The cost of such a work, of which more than half would be spent on providing railway accommodation, and not on harbour works proper, has been estimated at 17 millions of francs (£680,000).

THE FIVE HUNDREDTH ANNIVERSARY OF THE FOUNDATION OF THE UNIVERSITY OF ST. ANDREWS.

Sir John Cameron Lamb, C.B., C.M.G., Vice-President, and late Chairman of the Council, represented the Society at the celebration of the Five Hundredth Anniversary of the Foundation of the University of St. Andrews. The celebrations continued from September 12th to 16th, and were attended by between three and four thousand guests, including delegates from over a hundred universities and the leading learned societies of the world. The proceedings opened on the evening of the 12th with a reception by the Chancellor of the University, Lord Balfour of Burleigh. On the following morning the staff of the university and the delegates assembled in the quadrangle of the United College of St. Salvator and St. Leonard, and marched in procession to the town church, where a solemn service of thanksgiving was held. The scene was very impressive, owing to the distinguished character of many of those present, and the extraordinary brilliance of the academic and civic costumes. Some of the robes of the German professors were over two hundred years old, and one, at least, had been insured for the sum of £1,200.

In the afternoon the Chancellor, after reading a letter from King George V., in which his Majesty expressed his regret at being unable to be present at the celebration, and his deep sense of the national significance of the event, delivered an address of welcome to the guests—"the members of more than one hundred universities, and upwards of forty other societies, who have responded to our call from British dominions all over the world, from the United States, from Austria, Belgium, Denmark, France, Germany, Greece, Holland, Hungary, Italy, Norway, Russia, Sweden, Switzerland, and Turkey." The Chancellor's speech was followed by the presentation of addresses to the university by the delegates. In the evening the students gave, before a vast audience, a series of tableaux, depicting scenes from the history of St. Andrews.

The first ceremony on the 14th was the installation of the Lord Rector. Lord Rosebery, who had arrived at the harbour in his private yacht, and had been drawn by the students in an open carriage to the Principal's residence, delivered a brilliant oration on the state of Scotland in the fifteenth century, and the part played by St. Andrews in its subsequent history. After this, honorary degrees were conferred on a number of the delegates (including Mr. Asquith), and in the evening a banquet

was held, attended by some five hundred guests, at which the principal speakers were Mr. Balfour and Lord Rosebery.

On the 15th the guests proceeded to Dundee, whose University College forms part of the University of St. Andrews. After listening to further speeches from the Chancellor and the Lord Rector, the visitors were entertained at luncheon. A large ball given in the evening at St. Andrews brought the brilliant and memorable celebrations to an end.

HOME INDUSTRIES.

The Coal Mining Industry.—The Miners' Federation Conference has unanimously decided to support the demand of the Northumberland miners for a new wage agreement with a fixed wage minimum of 30 per cent. above the 1879 basis, and the abolition of the three-shift system. The principle of a fixed minimum wage for coal-hewers has been in operation in the English federated districts since 1894, and is now conceded in the wage agreements made in Scotland and south Wales. The 1879 basis for Northumberland meant 5*s.* 2*d.* a day, with a percentage based on the selling price of coal for the moment. That percentage is now 27½, and added to the 5*s.* 2*d.* makes the total roughly 6*s.* 6*d.* a day. What the miners now seek is an advance to 6*s.* 8*d.* a day, and a guarantee that the 6*s.* 8*d.* be a minimum for the future. As to the abolition of the three-shift system, the Northumberland miners say it imposes intolerable conditions on the home life of the miners. In some quarters a national stoppage of work is thought probable, and much will depend upon whether the Coal Owners' Association consents to a joint meeting to discuss the proposals. The conference of the Miners' Federation has shown that there is a cleavage between the moderate men and those who would precipitate a national strike as the best means of obtaining the changes demanded by the miners.

Pit-Brow Women.—There is sharp division of opinion between the labour leaders and women workers as to the clause in the Coal Mines Bill abolishing female labour at the pit-banks. On behalf of the Government, Mr. Masterman has promised that it shall be deleted, but at the Miners' Federation Conference held last week the following resolution was carried unanimously: "That this Federation make a special effort to preserve the Mines Bill as it passed through Committee on the abolition of female labour on pit-banks in future, and also the weekly payment of wages to workmen." The clause as it stands does not throw out of employment those now engaged at the pits, but requires that no other women be so employed. Notwithstanding this limitation, strong efforts will be made by the representatives of women workers to prevent Parliamentary interference with pit-brow workers, and it is proposed to hold a meeting in London on October 31st, at which twenty or thirty of the workers will be present to remove false ideas about their dress and appearance. Whatever else may be said against the work it cannot be said to be unhealthy, and its prohibition would be a serious loss to many households in certain districts. Opinion is much divided on the subject, but the great majority of the miners' representatives in the House of Commons will probably go into the lobby against the employment of women at the pits. That, however, is not conclusive as against their employment, and probably the dispute will end in a compromise which will impose some restriction in substitution for the abolition clause. The case for the women could not be more effectively put than it was by Mrs. Alfred Haworth, who spoke at a meeting held last week at Manchester to protest against the abolition of the work of women at the pit-brow. Referring to the deputation that recently waited on Mr. Masterman, to which reference has been made in these Notes, Mrs. Haworth said: "The deputation consisted of forty or fifty of the pit-brow women themselves. They had with them a doctor to testify to the healthiness of the work, and a clergyman to testify to the good morals of the workers, and they had also the manager of one of the pits. When they got to the House of Commons they were joined by a number of friendly members, including Mr. Stephen Walsh, an ex-miner himself and the member for Ince. It was an extraordinarily effective deputation. It proved a number of things; and, first of all, that work at the pit-brow was healthy work. No doctor in the neighbouring towns could be found who knew of any special illness among the women, and no lawyer could be found who knew of any case of injury having been taken into court under the Workmen's Compensation Act. It was proved, indeed, that the doctors of the neighbourhood were in the habit of recommending this work as healthy work for people who were inclined to consumption or anæmic, and it was said that of ninety workers at one pit thirty were actually there under doctors' orders. As regarded the conditions of work, the hours were short for a woman worker, eight hours a day for five days in the week, and the pay was comparatively good, the average wage being about 12*s.* a week. As to morals, Mr. Masterman said at once that there was no necessity whatever to go into that subject. Mr. Masterman promised the support of the Government in trying to delete this amendment when the Bill got back to the House of Commons, but he spoke of the possibility of certain regulations being made affecting the work of the women." Mrs. Haworth understood that the women did not want any regulations at all.

Cotton Statistics.—The statistics just published by the International Federation of Master Cotton Spinners' and Manufacturers' Associations give the total number of spindles throughout the world as 137,278,752. The estimated number of spinning spindles in Great Britain is given as 54,522,554. Of this number, 39,977,255 are mule spindles, and 8,050,925 ring spindles. Egyptian cotton is used

by 13,169,923 spindles, and 34,858,237 spindles are engaged on American, East Indian, and sundry cottons. At the present time there are in course of erection in Great Britain 896,934 spindles. The curtailment of production during the past season amounted to 113 hours in Great Britain, 140 hours in Germany, 105 hours in France, 419 hours in Austria, 339 hours in Italy, and 180 hours in Switzerland. The consumption of cotton per 1,000 spindles is 70·47 bales in Great Britain, 105·23 bales in Germany, 132·99 bales in France, 352·15 bales in India, and 162·65 bales in the United States. The stocks on August 31st of all kinds of cotton throughout the world are given as 2,619,052 bales, against 2,523,782 bales at the same time last year. The stock of American cotton is stated to be 1,135,166 bales, as compared with 1,123,526 bales twelve months ago. The consumption during the season ended August 31st last of all spinners throughout the world amounted to 17,819,070 bales, as against 17,030,511 bales during the previous year. The figures for American cotton are 11,559,401 bales, as compared with 11,145,678 bales during the previous year.

Shipbuilding.—In September the Scottish shipbuilders put into the water 54,427 tons, an amount that has only once been exceeded in a corresponding month. The total output for the Clyde yards in the nine months ended September was 195 vessels, representing 432,218 tons. These figures have only twice been exceeded, namely in 1906 by 30,000 tons, and in 1907 by 25,000 tons, and the work remaining on hand is said to be greater than the work which has been turned out during the year so far. Moreover, there are a number of contracts in negotiation. All the new ships are said to have found immediate employment, and there is still a demand for tonnage, but it remains to be seen what effect the war will have on freights. If it continues it can hardly fail to check over-sea contracts, but, meantime, shipbuilders are busy and shipowners doing fairly well.

Railway Rates.—The Manchester Chamber of Commerce has succeeded in bringing about an important concession in the railway rates for cheese and other dairy produce from the south of Scotland. The rate on cheese from Montreal to Manchester is 20*s.* a ton, but until last month the rate on cheese from the south of Scotland to Manchester was 35*s.* per ton, no matter how large a quantity was sent, whilst for margarine and "half-meat" cheese from the same district a special rate of 26*s.* 3*d.* per ton was granted, subject to the proviso that they must be in two-ton lots. It will be seen from these figures how greatly the Scottish farmers have been handicapped in competing with Canada for the cheese market. The two railway companies concerned have now granted a rate of 26*s.* 8*d.* all round, a rate now in force, and the restriction as to consignments of butter being necessarily in two-ton lots has been removed.

Jute.—A chart issued by Messrs. Joseph J. Barrie & Co., of Dundee, gives some suggestive figures bearing upon the present position of jute. Last year the crop was just under 8,000,000 bales, the consumption 8,497,774 bales. For the current season the estimate is of a crop of 8,319,700 bales, and the world's requirements are put at 9,240,703 bales. It would seem, therefore, that the supply of jute will not be equal to the demand, and a rise in price may be expected, and maintained until better crops replenish the supplies.

The National Insurance Bill.—If the statements of Ministers who have recently referred to the subject are to be taken as representing the final intentions of the Government, the Insurance Bill is to be passed through the House of Commons before the session closes, but the opposition to it continues to expand and deepen. Whilst influential sections of the labouring classes are actively opposing it, there does not appear to be enthusiasm for it anywhere. Take, for example, the numerous class which include warehousemen, salesmen, buyers, travellers, clerks, book-keepers, cashiers and others in receipt of a salary of not more than £160 per annum. They will come under the provisions of the Insurance Bill whether already voluntarily insured for sickness or not. They will have to pay 4*d.* per week, and their employers will have to pay 3*d.*, whilst the State adds 2*d.* per head, but the benefits do not appear to be commensurate, or anything like equal to those now given by the various provident associations of the country for a contribution of 6*d.* per week. But poor as are the benefits for friendly society members, they are considerably worse for those who are not members of such societies, for the thirteen weeks' benefit of 10*s.* per week and the thirteen weeks' benefit at 5*s.* per week during sickness only refer to those who are assured through "approved" societies. Others than these can only draw sickness benefit to the amount of their contributions less expenses of management, medical, and sanatorium fees, which means that such persons can only accumulate to their credit each year about £2 6*s.* to be drawn upon in sickness.

OBITUARY.

Frederick Braby, F.C.S., F.G.S.—By the death of Mr. Frederick Braby, which took place at his residence in Teddington on the 9th inst., the Society has lost a member of over fifty years' standing, he having been elected in 1859. He was the head of the firm of Messrs. Braby & Son, manufacturers of corrugated iron, whose large works at Deptford and elsewhere are well known; and he was conspicuous for his generous treatment of his employees and for his local benefactions. He published several works, amongst them being "A Wonderful House and its Tenant."

Sir Charles Bennet Lawes-Wittewronge, Bart.—Sir Charles Lawes-Wittewronge died on the 6th inst. at Rothamsted, Hertfordshire, after an operation for appendicitis. He was the son of Sir John Bennet Lawes, Bart., F.R.S., the famous agriculturist, who, with Sir Henry Gilbert, in 1893 received the Albert Medal of the Society "for their joint services to scientific agriculture, and notably for their researches, which, throughout a period of fifty years, have been carried on by them at the Experimental Farm, Rothamsted."

Born in 1843, young Lawes—he only assumed the additional name of Wittewronge in 1902—was educated at Eton and Trinity College, Cambridge. Here he distinguished himself greatly as an athlete, winning the first inter-University mile race in 1864, and becoming amateur champion for one mile in the following year. He also stroked the Cambridge eight in 1862, and won the Diamond Sculls at Henley in 1863, and the Wingfield Sculls in 1865. In later years he took up cycling with great enthusiasm, and held the amateur records for various distances up to twenty-five miles.

On leaving Cambridge, he devoted himself to sculpture, and exhibited numerous figures and busts. Perhaps his best-known work is the colossal group, "Dirce and the Bull," which is at present the central object in the Gallery of British Sculpture in the Rome Exhibition. He worked unremittingly at his art, and his interest in his profession was further shown by the help he gave towards founding the Society of Sculptors, of which he was the first president. Outside his studio his chief interest was the Lawes Agricultural Trust, of which he was chairman at the time of his death. He became a member of the Society in 1901.

GENERAL NOTES.

Production of Feathers in France.—Feathers form an important item of profit, judging from the following annual returns made by the wholesale dealers (" marchands de volailler en gros ") of sixty-eight out of the eighty-six Departments of France. No statistics are available for the remaining eighteen, which includes Paris and the Department of the Seine. No estimate can be given of the value of the feathers of poultry sold direct by producer to consumer.

	No. head.	Metric tons Weight.	Value. Francs.	£ sterling.
Geese	1,815,000	470	4,700,000	188,000
Turkeys	980,000	344	860,000	34,400
Ducks	1,680,000	140	560,000	22,400
Pigeons	1,210,000	70	280,000	11,200
Domestic Fowls (cocks and hens)	36,680,000	3,060	2,870,000	114,800

22,500 persons are engaged in the sixty-eight Departments in the purchase and plucking of the fowls, and 2,800 in sorting and preparing the fowls for sale.

State Insurance in England and Abroad.—A course of twelve lectures on this subject will be given at the London School of Economics, Clare Market, W.C., by Sir Edward Brabrook, C.B., Mr. H. B. Lees Smith, M.P., Mr. A. W. Watson, Mr. C. S. Loch, B.A., D.C.L., LL.D., Miss Marion Phillips, D.Sc. (Econ.), and the Hon. W. P. Reeves, Director of the School, on Mondays at 5 p.m., beginning on October 16th. The first lecture will be open to the public without fee.

MEETINGS FOR THE ENSUING WEEK.

Monday, October 16...Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. R. Unwin, "Town Planning, Formal or Irregular."

Tuesday, October 17...Faraday Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Discussion on following papers:— 1. Mr. J. Harden, "The 'Paragon' Electric Furnace and Recent Developments in Metallurgy." 2. Mr. Donald F. Campbell, "Progress in the Electrometallurgy of Iron and Steel." 3. Mr. E. Kilburn Scott, C.E., "The Hering 'Pinch Effect' Furnace."

Sociological, at the Royal Society of Arts, 18, John-street, Adelphi, W.C., 8.15 p.m. Mr. G. S. Lee, "The Bearing of Social Imagination upon Wealth."

Wednesday, October 18... Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. T. W. Butcher, "Structural Details of Coscinodiscus asteromphalus." 2. Mr. A. Flatters, "Abstract of Paper on the Wheat Plant." 3. Rev. Hilderic Friend, "New British Enchytraeids." 4. Mr. Walter Bagshaw, "Instantaneous Exposure in Photo-micrography."

United Service Institution, Whitehall, S.W., 3 p.m. Mr. C. E. D. Black, "A Proposed Railway from Egypt to India."

Thursday, October 19...Child Study, 90, Buckingham Palace-road, S.W., 8 p.m. Dr. A. B. Kingsford, "Co-Education during Adolescence."

Chemical, Burlington House, W., 8.30 p.m. 1. Mr. M. Banerjee, "The Action of Allium Sativum or Garlic-Juice on Lead and Mercury." 2. Messrs. E. Goulding and R. G. Pelly, "p-Methoxysalicyl-aldehyde and its Occurrence in the Root of a Species of Chlorocodon." 3. Messrs. A. G. Green and E. A. Bearder, "The Alkaline Condensations of Nitrohydrazo Compounds." Part I. 4. Mr. H. Christopher, "A Simple Piece of Apparatus for Sublimation in Vacuo." 5. Mr. J. B. Firth, "A Note on the Dehydration of Crystals." 6. Mr. F. P. Dunn, "The Diphenylcarbamidoximes." (Preliminary Note.) 7. Messrs. A. Lapworth and V. Steele, (a) "Some Properties of Phenyl Isopropyl Ketone," (b) "A New Stereoisomeride of Cyanodi-hydrocarvone." 8. Mr. V. Steele, "The Action of Hydrogen Cyanide on Carvone Hydrosulphide." 9. Messrs. A. McKenzie and F. Barrow, "Experiments on the Walden Inversion. Part VII.—Action of Phosphorus Pentachloride and of Thionyl Chloride on optically active Hydroxy Acids and Esters." 10. Mr. P. Neogi, "Preparation of the Nitrites of the Primary, Secondary, and Tertiary Amine Bases." 11. Mr. R. E. Slade, "Studies of Ammonium Solutions. Part I.—An Ammonium Electrode."

Mining and Metallurgy, at the Geological Society, Burlington House, Piccadilly, London, W., 8 p.m. Mr. H. S. Ball, "The Economics of Tube-Milling," and Mr. E. Coste, "Fallacies in the Theory of the Organic Origin of Petroleums."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. L. H. Piper, "Westminster Abbey."

Friday, October 20...Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Messrs. E. M. Eden, W. N. Rose, and F. L. Cunningham, "The Endurance of Metals; Experiments on Rotating Beams at University College, London."

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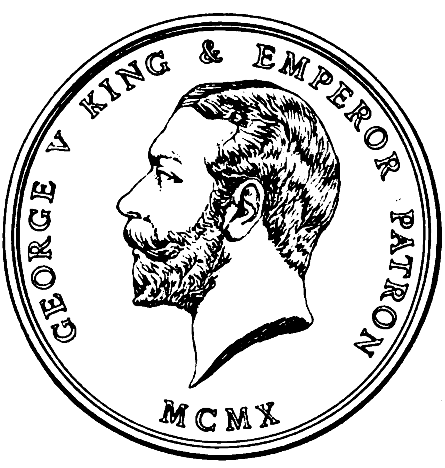
FRIDAY, OCTOBER 20, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

THE SOCIETY'S MEDAL.

It was mentioned in the last Council Report that H.M. King George V., on becoming Patron of the Society, had graciously consented that his head should be engraved on the medal, and had expressed the wish that the work should be carried out by Mr. Bertram Mackennal, A.R.A. The die was prepared from Mr. Mackennal's model by Mr. Allan Wyon, and an illustration of the new medal is now given. This die will



THE SOCIETY'S MEDAL.

be used in future for the Society's medals, including those gained at the examinations held in April last, and those awarded during the past session, which will be presented by the Chairman at the opening of the new session next month. The first medal struck was presented to his Majesty, who has intimated his warm approval of it.

No change has been made in the reverse of the medal.

EXAMINATIONS.

The programme for 1912 is now ready. The price of the programme (containing the previous year's papers and the examiners' reports on the work done) is 3*d.* (post free 4½*d.*). Copies can be had at this price on application to the Secretary, Royal Society of Arts, Adelphi, W.C.

The examinations are arranged under the following stages: — Stage I. — Elementary; Stage II. — Intermediate; Stage III. — Advanced.

The subjects include: — Book-keeping, Accounting and Banking, Shorthand, Type-writing, Economics, Précis-writing, Commercial Law, Commercial History and Geography, Arithmetic, Business Training, Handwriting, and Modern Languages.

The examinations will commence on Monday, March 25th, 1912.

In the Advanced and Intermediate Stages First and Second-class Certificates will be granted in each subject.

In the Elementary Stage Certificates will be given in each of the subjects enumerated. These will be of one class only.

Certificates of proficiency will be granted in each stage to Candidates who pass in certain specified subjects during a given period.

In Rudiments of Music Higher and Elementary Certificates will be given; in Harmony Higher, Intermediate, and Elementary Certificates.

A fee of 2*s.* 6*d.* will be required by the Society from each Candidate in each subject in the Advanced and Intermediate Stages, and in the Elementary Stage a fee of 2*s.* for one subject, and 1*s.* for each additional subject taken up by the same candidate. The fees for Harmony and Rudiments of Music are the same as for Stages II. and III.

Medals and Prizes are offered in each subject in Stages II. and III. Full particulars will be found in the programme.

Examinations are also held in the Practice of Music, and Vivâ Voce Examinations in French, German, Spanish Portuguese, and Italian. For information as to these examinations reference should be made to the programme.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

ROCK CRYSTAL: ITS STRUCTURE AND USES.

By Alfred E. H. Tutton, M.A., D.Sc., F.R.S.

Lecture III.—Delivered May 15th, 1911.

The most important and convincing evidence of the right- and left-handed screw structure of quartz is afforded by the optical properties of the mineral, to which this third lecture will be devoted. In common with all crystals belonging to the trigonal system of symmetry, as well as those of hexagonal and tetragonal symmetry, the three systems which are optically uniaxial, the optical characters are graphically symbolised by an ellipsoid of revolution, the axis of which is the trigonal axis of symmetry, the axis of the prism in the case of quartz. The ellipsoid may be constructed so as to express the value of the refractive index of rays vibrating along any direction within the crystal; that is, the ellipsoid in this case is such that any principal section (a section containing the axis) is an ellipse the major or minor axis of which represents the value of the refractive index ϵ of a ray composed of waves vibrating parallel to the trigonal axis, while the minor or major axis of the ellipse, at right angles to the one just referred to, expresses the refractive index ω of a ray vibrating perpendicularly to the trigonal axis in the circular section of the ellipsoid. Now these two refractive indices, ϵ and ω, are the two extreme values of the refractive index for the whole crystal. Other radii of the ellipse express by their lengths the intermediate values between these two extremes. If this ellipsoid of refractive index be an elongated one, owing to ϵ being greater than ω, the crystal is conventionally termed positive, and this is the case with quartz; if it be oblate, ω being the greater, it is called negative, and calcite is an excellent example of this type of uniaxial crystal. The difference between ϵ and ω is the measure of the amount of the double refraction. This is small in the case of quartz, namely, 0·0091, for $\epsilon = 1·5534$ and $\omega = 1·5443$; but it is very large in the case of calcite, being 0·1719, for $\epsilon = 1·4864$ and $\omega = 1·6583$.

If, therefore, we pass a beam of light along the axis of a quartz crystal or any other uniaxial crystal (the term uniaxial referring to the property, to be subsequently discussed, of a single "optic axis" being exhibited along the singular axis of revolution of the ellipsoid, the axis likewise of trigonal symmetry and of the prism in the case of quartz), the light vibrations, always perpendicular to the direction of propagation, may continue to vibrate in any and every azimuth parallel to the circular section of the ellipsoid, with the same velocity and, therefore, the same refractive index, this latter being the inverse measure of velocity. There is consequently no double refraction experienced by such a beam travelling along the prism-axis of quartz. But if the beam be otherwise directed, double refraction does occur, and to its maximum extent when the beam is sent along the equatorial plane of the crystal, the circular section of the ellipsoid. It is then separated into two distinct rays, one vibrating in the equatorial plane perpendicular to the axis, but at right angles to the direction of propagation of the beam, and another vibrating parallel to the axis. All other rays of intermediate character are eliminated by mutual destruction. These two surviving rays travel with different velocities, inversely proportional to the two refractive indices ω and ϵ.

Indeed, if we cut the crystal in the shape of a 60°-prism, with its refracting edge parallel to the trigonal axis, that of the original crystal-prism, we shall find that the two rays are differently refracted, and that we obtain two spectra, one corresponding to each ray, from the prism, instead of only a single spectrum as given by glass. Moreover, the different amounts by which the two spectra are deviated from the direct line of propagation of the beam afford us the direct measure of the two refractive indices ϵ and ω. For we have only to place the 60°-prism on a spectrometer, and to determine in the ordinary well-known way the minimum amount of deviation suffered by each ray—that is, the minimum deviation of the two images of the collimator slit as seen through the telescope, using monochromatic light of a suitable series of wave-lengths—in order to be able to calculate, with the aid of the additional knowledge of the exact refracting angle of the prism, as measured on the same instrument, the actual values of

the two refractive indices ϵ and ω. We discriminate which image of the slit belongs to the one, vibrating parallel to the refracting edge of the prism and to the trigonal axis, and which corresponds to the other, vibrating in the

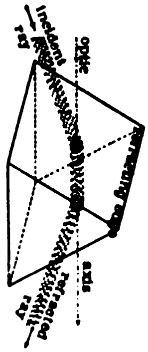


FIG. 21.—60°-PRISM CUT FOR LIGHT TO TRAVERSE AXIS.

perpendicular direction, and in the circular section of the ellipsoid, by means of a Nicol prism; for one image is extinguished when the Nicol is in one position, and the other is quenched when the Nicol is rotated 90°, the known direction of vibration of light transmitted by the Nicol affording us thus the exact knowledge as to which image corresponds to which index.

With these elementary facts before us, we may now investigate the behaviour of quartz. First, we may study the effect of passing the light from the lantern, a slit in front of which is focussed on the screen by a lens, through two 60°-prisms, one cut so that the light passes through the crystal at minimum deviation parallel to the axis, as shown in Fig. 21, and another as just described, with the refracting edge parallel to the trigonal and optic axis, as shown in Fig. 22. In the latter case we see two spectra on the screen, which are separately extinguished by a large Nicol prism placed in the path of the rays, when rotated to two positions 90° apart; while in the former case only a single spectrum is produced on the screen, and remains permanent when the Nicol is placed in position and rotated, just, in fact, as if the quartz prism were made of glass. This is the mode of cutting quartz prisms employed for use in experiments with ultra-violet light, such as the investigation of the ultra-violet spectrum, quartz being remarkably transparent to these ultra-violet rays of short wave-length, which are entirely cut off by glass.

In the case of a quartz prism cut (as shown in Fig. 22), the two spectra are very close together, as the double refraction of quartz is weak, ϵ and ω not being very different (1·5534 and 1·5443). But in the case of calcite, a very strongly doubly refractive mineral, they are far apart, corresponding to the much greater difference between ϵ and ω (1·4864 and 1·6583).

If we examine a prism of a crystal such as fluor-spar or rock-salt, belonging to the cubic system, we obtain only one image of the slit, which is permanent for all positions of the Nicol. For the ellipsoid of revolution of a uniaxial crystal becomes a sphere when the perfect symmetry of the cubic system is reached, the optical properties, and therefore among them the most important of the optical constants the refractive index μ, being alike in every direction in a cubic crystal. On the other hand, if we cut prisms out of a crystal belonging to either the rhombic, monoclinic, or triclinic system—such as gypsum, the hydrated sulphate of lime, $CaSO_4.2H_2O$, the beautifully clear transparent crystals of which are currently known as selenite and which crystallises in the monoclinic system—we find no direction of truly single refraction, but in general obtain two spectra, however the 60°-prism may be cut. As we shall see subsequently, it is true that there are two positions of approximate single refraction, the two "optic axes" from which these crystals are called "biaxial"; but these are fortuitous positions not identical with any axes of the optical ellipsoid, although essentially symmetrical thereto. Any 60°-prism cut for the purpose of determining the refractive indices of gypsum or other biaxial crystal, with its refractive edge parallel to a principal axis of the

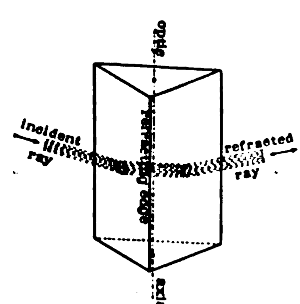


FIG. 22.—60°-PRISM WITH REFRACTING EDGE PARALLEL AXIS.

optical ellipsoid and its bisecting plane parallel to this and to a second principal axis, will always show two spectra, and afford thereby the two different refractive indices corresponding to light waves vibrating along those two rectangular

principal axes of the ellipsoid. Thus the revolution ellipsoid of the uniaxial systems becomes in the biaxial systems one of general form having three unequal rectangular axes, corresponding to three different refractive indices, α the smallest, β an intermediate, and γ the greatest index. The particular prism of gypsum experimented with affords α and γ, the two extreme indices, and their separation being small it is readily perceived that gypsum is not a substance of strong double refraction.

Let us now pass from the study of 60°-prisms to that of plates. A plate of a cubic crystal behaves optically just like glass, but one of either a uniaxial or a biaxial crystal affords highly interesting phenomena of a characteristic nature, which at once enable us to allocate the crystal from which the plate is cut to one of these two great divisions of crystals. The indications are particularly clear and decisive if the beam of light be made convergent, and the light itself be polarised, the Nicols being crossed. For if the plate be cut perpendicularly to the axis of a hexagonal, tetragonal, or trigonal crystal we obtain the well-known concentric spectrum-coloured rings, resembling those of Newton but crossed by a rectangular dark cross, the arms of which mark the directions of vibration of the crossed Nicols, as shown in Fig. 23. If, however, the crystal be rhombic, monoclinic, or triclinic, and the plate be cut perpendicularly to the particular axis of the optical ellipsoid which corresponds to that one of the two extreme refractive indices α and γ which is furthest removed from the intermediate index β, we obtain a figure showing two such ring systems, or "optic eyes," each with its own series of rings as shown in Fig. 24, and the exact positions of which are indicated by the vertices of two dark hyperbolic "brushes" into which the dark cross (one limb of which joins the two optic axes) opens out when the plate, or the pair of Nicols simultaneously, is rotated 45°, the conditions chosen for Fig. 24.

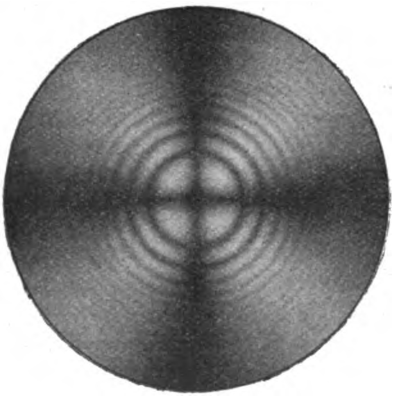


Fig. 23.—Uniaxial Interference Figure.

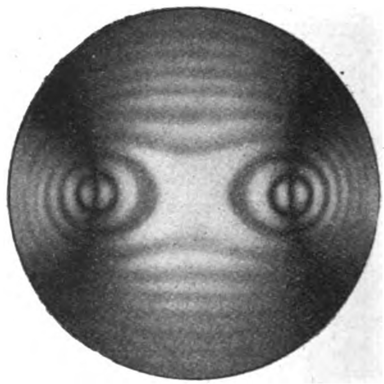


Fig. 24.—Biaxial Interference Figure.

Now we may take calcite and aragonite as two very typical normal cases of uniaxial and biaxial crystals, and show their optic axial figures on the screen with the aid of the projection polariscope. The former affords a very typical uniaxial figure, which remains unaffected on rotation of the plate. Aragonite possesses a small optic axial angle, 30° 52′ for sodium light as seen in air, but only 18° 11′ within the crystal itself. The angle varies somewhat with the wave-length, but not so much in the case of aragonite as in many other well-known cases.

We next proceed to study quartz, the special subject of these lectures, being now armed with the knowledge of the normal phenomena to be expected from a uniaxial crystal. Placing first a thin plate of quartz (one millimetre thick) in the polariscope arranged for convergent light, we perceive a more or less normal uniaxial figure, although the rings are large and diffuse and the dark cross present is also very diffuse, the whole figure wanting the sharpness of that afforded by calcite. If we now take a thicker plate, say one 3·75 millimetres thick, a thickness which is very convenient as will presently be shown, we observe that the coloured rings are more numerous, the innermost being smaller, and the arms of the cross sharper near the margin of the field; but they have entirely disappeared from the centre of the figure, as shown in Fig. 25, and the whole of the interior of the innermost ring is filled instead with yellow light. Moreover, if we rotate the analysing Nicol clockwise we observe that this ring

expands if the plate has been cut from a right-handed crystal of quartz, but contracts if the crystal be a left-handed one, the circular nature of the ring also altering until it is nearly square. If, now, we superpose two such plates 3·75 millimetres thick, one of right-handed quartz and the other of left-handed, we obtain a remarkable change in the figure, namely, the production of the celebrated spirals of Airy, as shown in Fig. 26.*

Now these phenomena at once suggest to us a spiral, and a complementarily helical, arrangement of the atoms composing the chemical molecules of silica in the two forms of quartz crystals. That the supposition is correct may be proved, as first shown by Reusch, by reproducing the effects by means of a spirally arranged pile of biaxial mica films, twenty-four equally thin films of ordinary muscovite mica

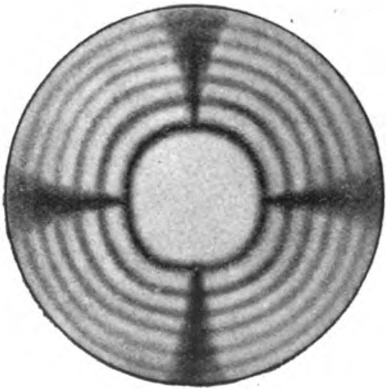


FIG. 25.—QUARTZ FIGURE.

such as can be bought in sheets being adequate. They are laid over each other so that the direction of the line joining the two optic axes of the mica regularly rotates by the same angle, say 60°, which is a very suitable angle of variation. For if the pile be arranged in a right-handed screw, of four turns, six films going to each complete turn, the biaxial figure normally given by muscovite mica, which is shown in Fig. 27, will be found on placing the composite pile in the polariscope to have been converted into a uniaxial one. Moreover, the figure resembles that afforded by quartz to a remarkable degree of precision, for if the pile be a right-handed one the figure is similar to that afforded by right-handed quartz, and gives the same effects on rotating the analyser; whereas, if the pile of mica films had been wound in a left-handed screw the effects produced would resemble those afforded by a plate of left-handed quartz. Further, the proof of the helical structure of quartz is completed by the interesting fact that if we superpose the two piles of mica plates, the left-handed and the

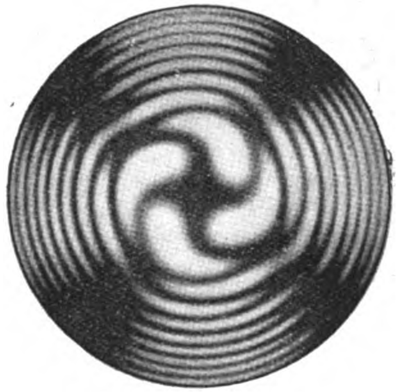


FIG. 26.—AIRY'S SPIRALS.

right-handed, and place them together in the polariscope, Airy's spirals are at once produced on the screen.

Let us now proceed to study quartz plates in a parallel beam of polarised light. If we take two plates, one of right-hand quartz and the other of left-hand, each of 7·5 millimetres thickness, we find that they each give with crossed Nicols the well-known rose-violet tint of passage, between the first and second orders of Newton's spectra. But on rotating the analysing Nicol clockwise the right-handed plate changes colour first to red, then to orange, yellow, green, and blue, while the left-handed plate becomes first blue, then passes through

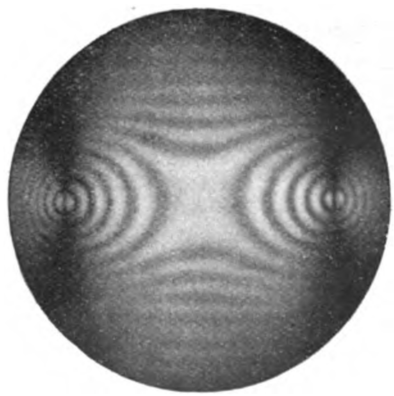


FIG. 27.—MUSCOVITE MICA FIGURE.

green and yellow to orange and red. On the other hand, the two plates of 3·75 millimetres thickness appear yellow under crossed Nicols, just as were the centres of the interference

figures in convergent polarised light, and they change colour in opposite directions of the spectrum on rotating the analyser, until they become violet with the tint of passage when the Nicols are parallel.

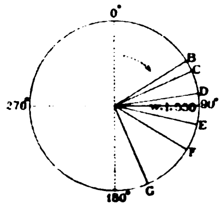


FIG. 28.—ROTATIONS BY 3·75 MM. OF QUARTZ.

Now all these beautiful phenomena are due, as we have already surmised, to the fact that when a beam of light is sent along the axis of a quartz crystal, the right- or left-handed arrangement of the molecules of silica causes the plane of vibration of the polarised light received from the polarising Nicol to be rotated in the same direction, the amount being directly proportional to the thickness of the plate. It also varies considerably with the wave-length of the light. For plates of 3·75 and 7·5 millimetres thickness respectively the rotations by plates one millimetre thick are to the extents indicated in Figs. 28 and 29. It will be obvious from Fig. 28 that the plane of vibration of yellow light of wave-length 0·000550 is rotated just 90° by a plate of 3·75 millimetres thickness, and this fact at once explains the production of the violet tint of passage when we have rotated the analysing Nicol 90°, that is, until it is parallel to the polarising Nicol. For the extinction of this yellow light leaves the complementary colour, the violet transition tint, predominant. And when we double the thickness of the plate to 7·5 millimetres the yellow ray of 0·000550 millimetre wave-length is rotated just 180°, as shown in Fig. 29, which brings the

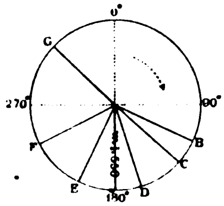


FIG. 29.—ROTATIONS BY 7·5 MM. OF QUARTZ.

Nicols into the crossed position again if we attempt to follow the rotation, and thus the violet transition tint is at once given by such a plate under crossed Nicols, the effect being the same whether we leave the Nicols in their original position of crossing or rotate either of them for 180°.

Several modes of demonstrating the rotation of the plane of polarisation by quartz may profitably be shown. The most striking of them is due to Professor S. P. Thompson. A circular film of mica constructed of twenty-four sectors is used. Each sector is obviously of 15° angle, and the film is so chosen and cut that the angle is bisected by the line joining the two optic axes of the mica crystal. The thickness of the film is such as corresponds to half a wave-length of retardation of one of the two rays produced by the double refraction of the mineral behind the other. The sectors are cemented by balsam between a couple of glass plates in close contact so as to produce a circular disc. On placing the arrangement in the polariscope with crossed

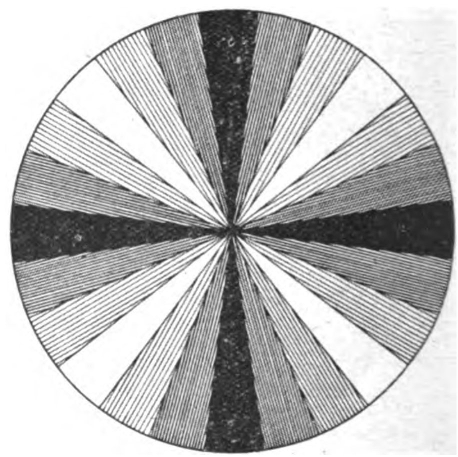


FIG. 30.—PROFESSOR THOMPSON'S MICA SECTORS.

Nicols a black cross is seen on the screen, as shown in Fig. 30, the four sectors, the bisecting lines of which are vertical and horizontal, being in their extinction positions, the two principal rectangular axes of the optical ellipsoid of mica being parallel to the vibration directions of the two Nicols. The sectors at the 45°-diagonal positions are brightly illuminated by colourless light, and the other intermediate sections appear more or less shaded in graduated tints of sepia. On now introducing a plate of quartz one millimetre thick in the path of the beam from the lantern the black cross is rotated one sector to the right or left, according as the plate has been cut from a right-handed or a left-handed crystal or quartz, the jet blackness of the cross being also changed to a deep vandyke-brown.

The colour produced by thick plates of

quartz in polarised light is thus due to optical rotation, and the colour is quite as brilliant as that due to double refraction shown by thin plates of quartz, such as those of rock-sections, which vary from a twenty-fifth to a fiftieth of a millimetre in thickness. The phenomenon of optical activity is confined to crystals belonging to those eleven classes of symmetry which exhibit right- and left-handed forms, that is, in which there is no plane of symmetry developed. Now besides the ordinary right- and left-handed forms, as shown by trigonal quartz and by monoclinic tartaric acid, a most interesting substance from the point of view of the phenomenon in question, chemists have discovered many cases in which the optical activity is either masked, neutralised, or destroyed by intimate lamellar twinning of the two complementary varieties or by chemical combination of the two sets of molecules in which the atoms are oppositely spirally arranged. In the former case of regularly repeated twinning the symmetry is apparently enhanced by the introduction of a plane of symmetry, the composite crystal showing the characteristic faces of both right- and left-handed forms. In the latter case chemical combination results in the production of a new substance, and the crystalline form is altogether different, and may even belong to another system. This is the case with tartaric acid, for the combination of the two sets of molecules produces racemic acid, which crystallises in the triclinic system with a molecule of water of crystallisation, totally unlike the crystals of either ordinary dextro (right-handed) tartaric acid or the complementary lævo (left-handed) tartaric acid, both of which belong to the sphenoidal class of the monoclinic system and are anhydrous. A pair of such complementary crystals of the two varieties of tartaric acid are shown in Fig. 31. Racemic acid is optically inactive, the case being thus one of external compensation, that is, by union of the complementary molecules.

Molecular compounds of this character, however, are often weak, and in the cases of certain salts of racemic acid, ammonium sodium racemate for instance, the product of crystallisation is often found to be a mixture of the two complementary varieties of the testrates, dissociation of the feeble chemical union having occurred.

Besides this production of optical inactivity by the chemical union of the two optical antipodes, that is, by compensation and mutual destruction of optical activity by bodily union from without, and doubling of the molecular constitution, there is another mode of production of an inactive variety possible, by compensation within the molecule itself, whenever there are two groups of atoms surrounding two carbon atoms which can arrange themselves in mirror-image fashion, the two halves of the molecule being thus mutually symmetrical to a symmetry plane. Such occurs in the case of the truly inactive variety of tartaric acid, for this modification of the acid can under no circumstances be split up into two optically active components.

Now the racemic form of optical inactivity, the form produced by external compensation (outside the molecule), is often simulated to a most remarkable extent by the repeated twinning already referred to; but such forms can generally be readily distinguished from truly racemic forms by the crystallographic fact, that whereas a truly racemic form exhibits another and quite distinct crystallographic form, usually belonging to another class or even system of

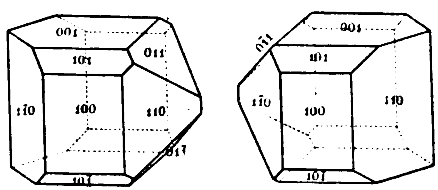


Fig. 31.—The Two Forms of Tartaric Acid.

symmetry, the "pseudo-racemic" form exhibits the symmetry of the same system, although most probably that of a class of higher symmetry in the system, owing to the introduction of a plane of symmetry, about which the twinned individuals are disposed in mirror-image fashion. This case of the mechanical enhancement of the symmetry by repetition twinning is beautifully illustrated by quartz, especially in the exquisite form of the mineral known as amethyst. In order to understand this further extremely interesting lesson to be learnt from rock crystal, we must first study the optical characters of twins of the right-handed and left-handed varieties of quartz; indeed, it will well repay us to consider also as a preliminary two kinds of artificial combinations of the two varieties of quartz.

The first kind of composite quartz, the well-known "biquartz," is, moreover, of great practical value. Two plates of equal thickness are cut and polished out of a right-handed and a left-handed crystal respectively, of either 3·75 or 7·5 millimetres thickness, truly at right angles to the optic and trigonal axis. An edge-

face is ground and polished on each, perpendicular to the plate, and thus truly parallel to the axis, and the two plates are then cemented together by this narrow face, which becomes almost invisible as the cementing Canada balsam has almost the same refractive index (1·548) as

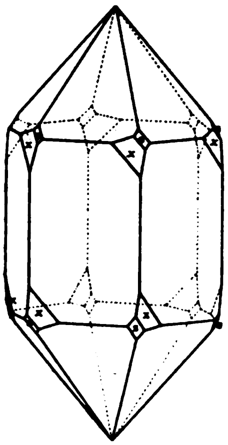


FIG. 32.

quartz, so that the plate appears as a single one. Such a composite plate, under crossed Nicols, if of 7·5 millimetres thickness or under parallel Nicols if half that thickness, exhibits an even transition violet tint, the line of junction being invisible. But the moment the analysing Nicol

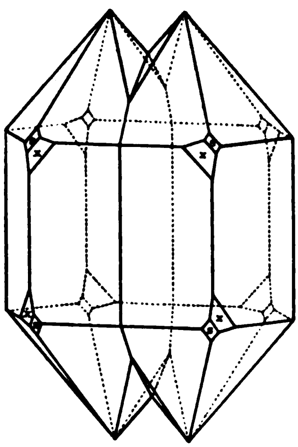


FIG. 33.

is slightly rotated, or another optically active substance or quartz plate is introduced into the path of the rays, difference of colour becomes apparent in the two halves, the biquartz thus acting as a very delicate test either for the adjustment of the Nicols to crossing or parallelism or for optical rotation in another substance. For this latter reason it is much used in saccharimeters, polariscopes for the determination of the optical rotation of sugars and other optically active substances.

The second kind of artificially composite quartz plate is one in which the narrow side-face of junction is made oblique to the plate, being ground say at 45° or 60° to the plate surfaces. The two plates thus similarly bevelled, of respectively right-handed and left-handed quartz, are then cemented together in a mutually inverted manner, so as again to form a continuous plate. When such a plate is examined in the polariscope under crossed Nicols, the area of overlapping is observed to be marked by a black band, and if the angle of obliquity of the junction be as much as 45° a white band will appear on each side of the black one, and outside this again a spectrum band is usually shown,

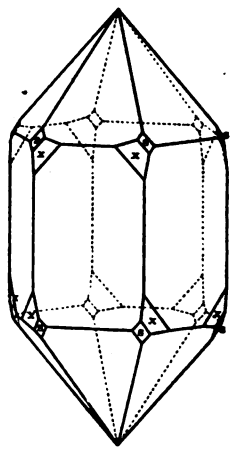


FIG. 34.

the whole elongated strip having the appearance of a ribbon coloured at the margins and black along the central line, with intermediate white strips. The black band marks the line of exact neutralisation of the rotations produced by equal thicknesses of right and left quartz, and the spectra mark the gradual increase of preponderance of thickness of one variety over the other.

Proceeding now to the study of natural quartz twins, it must first be made clear that there are two well-marked kinds of quartz twins, one in which the two individuals are of the same right- or left-handed variety, and another in which a right-handed crystal is twinned with a left-handed one. An example of the former type is shown in Fig. 32, which represents a twin of right-handed quartz, one of the two right-handed crystals of which is situated with respect to the other as if, starting parallel, it had been rotated for 180° about the vertical trigonal axis,

but with complete interpenetration, in the case actually shown, of the one individual within the other. The tangible result is an apparently single crystal, but with the little pyramidal and trapezohedral faces *s* and *x* similarly orientated on every corner, arranged in a right-handed manner, instead of on alternate quoins only.

The other kind of quartz twin, frequently found occurring among specimens from Brazil, is represented in Fig. 33 by a case of partial interpenetration, and in Fig. 34 by an example in which complete interpenetration has occurred. The plan of the twinning is that the twin plane is a face of the hexagonal prism of the second order, perpendicular to a pair of the faces of the hexagonal prism present, which is of the first order. When interpenetration is complete, as in Fig. 34, the little *s* and *x* faces are shown on every corner, but symmetrically, as if the crystal were of holohedral symmetry.

Now, if a section-plate of such a crystal be cut, of 3·75 or 7·5 millimetres thickness, perpendicularly to the axis, the polarisation phenomena, due to the opposite optical activity of the two different varieties present, will vary according to the mode of internal disposition of the parts composed of the two varieties, right- and left-handed. When the whole of one half of the crystal is of right-handed and the other of left-handed quartz, and the surface of junction is a plane parallel to the axis, we have a natural biquartz produced on cutting such a section-plate, which shows absolutely no trace of a junction-plane in ordinary light or when the Nicols are crossed or parallel, but which exhibits different colours in the two halves the moment either Nicol is rotated to even the slightest extent. Two such natural biquartzes are exhibited on the screen. They are excellent examples, obtained after long searching.

If the plane of junction be oblique, however, the biquartz shows a black band between the two halves when the Nicols are crossed, and a white one when they are parallel, as is the case with the natural biquartz next projected on the screen, the obliquity of the junction plane not being great in this example. A third natural biquartz, with a junction-plane of greater obliquity, next exhibited, shows not only the central black band but a white one and a spectrum on each side of it, very like the artificial specimen already referred to and illustrated on the screen.

A very instructive case is that of a natural quartz twin-combination, which by its picture on the screen in polarised light is seen to be composed of one half of left-handed quartz, which polarises in a rich crimson lake with crossed Nicols, and a second half which is made up of alternating right- and left-handed quartz, the strips being joined obliquely to the plate, so that a black band is produced in each case as the central line of a ribbon, being flanked by a white band and a spectrum band on each side. A faint idea of this screen picture may be gathered from Fig. 35.

Now, such a banded structure of alternately right- and left-handed quartz affords an instance on a larger scale of the finely-laminated twinning of the two varieties present in amethyst. Several further examples of ribbon-band structure may first be referred to, however, such as a particularly fine one in which the ribbons form the boundaries of V-shaped

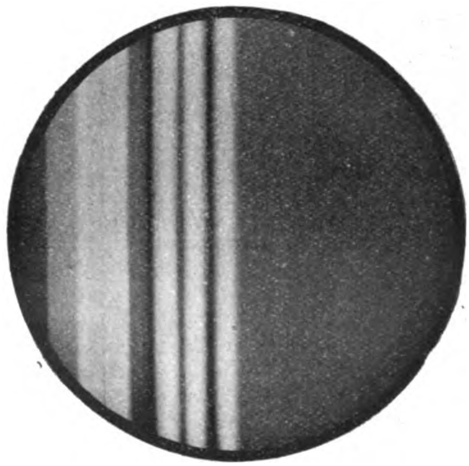


FIG. 35.—BANDED QUARTZ TWINNING.

intrusions, of 60° or 120° angle, of one variety in a crystal of the other variety. Also many very beautiful cases of irregular composition occur, such as the cases next projected on the screen, one of which gives a polarisation effect like snow mountains with green bases, intruding upwards into a blue sky, reminding one of many a glorious Alpine expedition.

The case of amethyst is an exceedingly beautiful and highly instructive one. A plan of the effect seen on the screen with a typical section perpendicular to the axis of an amethyst crystal is shown in Fig. 36. The marginal parts show polarisation colours in three sectors, *x*, *y*, *z*, indicating the presence of right- or left-handed quartz, *y* being left- and *z* right-handed; *x*, however, is composite, the upper part, x_r, being right-handed and the lower part, x_l, left-handed, and where the two join there is overlapping, and

a ribbon band, x_{rl}, with black line in the middle, is produced. The convergent light phenomena correspond, z and x_r giving a right-handed uniaxial figure and y and x_l a left-handed interference figure, while x_{rl} affords Airy's spirals. The alternate sectors A, B, C, however, show no definite polarisation-colour phenomena, except the natural violet colour which is characteristic of these alternate sectors and is the distinctive feature of most amethysts: hence the name. But in the central halves these sectors exhibit the beautiful laminated twinning effect, under crossed Nicols a delicate slate-coloured line marking the junction of each pair of right and left laminæ, each lamina itself appearing as a thin white band between the slate defining line shaded by traces of spectra. On rotating the analysing Nicol the laminæ exhibit the most

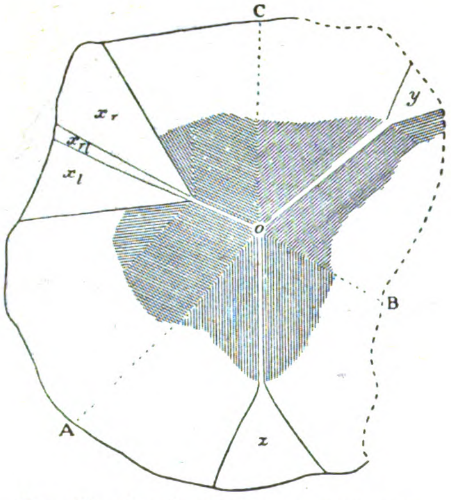


FIG. 36.—THE STRUCTURE OF AMETHYST.

beautiful shades of grays and browns, with delicate linings of rose and other tints. This central part of the plate, moreover, is unique among quartz crystals in exhibiting a uniaxial interference figure in convergent polarised light of the normal kind—that is, with the black cross complete to the centre, just as is afforded by calcite or other non-rotating normal trigonal, hexagonal, or tetragonal crystal.

Thus the intimate lamellar twinning of the two varieties of quartz in amethyst obviously results in the production of a crystal which simulates holohedral trigonal symmetry, the lower-class symmetry in which one variety is the mirror-image of the other being apparently enhanced, so that the one individual crystal itself displays mirror-image symmetry—that is, the presence of a symmetry plane—and the corresponding optical activity of the lower-class pair of varieties is neutralised by their intimate blending. Amethyst, therefore, is not a case of true optical inactivity, but of mechanically and naturally produced pseudo-inactivity. It is thus an excellent illustration on a large scale of the still more intimate blending of microscopic or even submicroscopic laminæ of the two varieties in the organic substances known to chemists as pseudo-racemic compounds, a large number of which have been studied by Kipping and Pope. In many of these cases the blending of the two varieties by regular intercalation and alternation of the two varieties, one within the other, is so intimate that the laminæ approach the molecular dimensions in thinness. It is easy to see that if the approach be continued until this fascinating region of molecular forces is penetrated—for we know that within four or five molecular diameters these intermolecular forces come into play—it is more than likely that some sort of molecular chemical affinity will develop, with the possible production of a molecular compound—a racemic compound—of the two hitherto alternating varieties, the individuality of each variety being no longer preserved, but a new compound, due to the new double molecule, being produced and crystallographically developed according to its own new crystalline form. Thus both the pseudo-racemic form, of which quartz affords us a gross but excellent example, and the true racemic form, are produced by external compensation of the two different molecules mutually by each other; but whereas in the true racemic compound this occurs within the range of action of the molecular forces, in the case of the formation of a pseudo-racemic substance the intimate intercalation occurs outside the effective range of molecular action capable of producing chemical union. An example of such intimate blending by repetition twinning of the ultra-microscopic order is afforded us by potassium chlorate crystals, which are often twinned in layers of such extreme tenuity, not more than the thousandth of a millimetre in thickness, that the crystal faces yield magnificent colours by reflected light alone, without any necessity for the use of polarised light. The reason for this display of the colours of thin films by such crystals has been fully explained by Stokes and Lord Rayleigh, and the most striking result of their investigations, and that of other workers on such substances, has been to show the wonderful equality of thickness of the layers, the two alternating individuals

balancing one another perfectly. So it undoubtedly is in the cases of pseudo-racemic substances, the layers of the two (right- and left-handed) varieties being so truly equal in thickness that the net result is the balanced display of holohedral symmetry instead of the one-sided lower-class symmetry of the system.

In enabling us to grasp this remarkable advance in our knowledge, both of these interesting cases of crystalline structure and of the intricate chemical properties and relationships of optically active substances, quartz has indeed shown itself as the most instructive and uniquely interesting of all the crystallised substances of the natural mineral world.

THE FRENCH PRESERVED FRUIT INDUSTRY.

For a great many years a particularly favoured corner of Provence—the commercial centre of which, so far as the production of preserved fruits is concerned, is Apt—has furnished the choicest preserved, or in popular parlance "candied," fruits, which reach either the European or American markets. In spite of a high rate of customs duty and an abundance of American fruit, these special products have found a ready sale in the most expensive establishments in the United States. The fruit preservers in Apt and in Marseilles have also shipped to America large quantities of cherries simply preserved in brine, which thus escape the high duty applied to fruits preserved in sugar and arrive in proper condition to absorb various liquors, and then to be sold as "Maraschino cherries," and probably under other descriptions. The terms under which the French fruits are sold have passed into the English language. The trade understands the meaning of the words "fruits confits" and "fruits glacés." The former are fruits which retain their natural form and colour and have absorbed quantities of sugar; the latter only differ from the former in that they have been re-dipped and given a crystalline coating of sugar, so that they are dry to the touch and agreeable to handle. The American Consul at Marseilles says that in connection with the preserving process, healthy fruit is selected which is gathered before its maturity, so as to be able to resist the succeeding operations. The first step is to soften the flesh so that it may absorb the sugar, and particular attention is paid in the case of fruit like the pear, walnut or quince, the pellicle of which is removed before the process begins, lest the white flesh thus exposed should become rusty in appearance. To avoid this, fruits of this kind, from which the skin and defective parts have been removed, should be thrown into fresh water that has been slightly acidulated with lime-juice or concentrated vinegar, or, better still, with alum. The pared fruit should not be touched with the hands, but with a long pin, and should be held in this preliminary bath only long enough for the preparation of a sufficient quantity to begin the softening operation. The next important step is to soften the fruit through and through, so that it will absorb the sugar readily. Alum water is recommended for this purpose, and in such quantity that none need be added later after evaporation has reduced the original quantity. With pears, they should "swim well" in a double-bottomed vessel, steam heat preferably being employed. An experienced workman knows, by gently passing the fruit between his fingers, whether or not it is soft through and through. If it is boiled too much it becomes a sort of marmalade, if not enough it will not absorb the sugar. Properly softened, the contents of the boiler are placed in fresh water, which is changed until they become perfectly cool. Pears may be heated until flexible and tender and then pared, or may be pared and then softened. Fruits containing pits, like peaches or cherries, are placed in cold water, over a slow fire, and as they rise in the water they are removed, tested to ascertain whether they are soft enough, and then thrown into cold water. Quinces are cut into four, five, or six pieces before being softened. For Reine Claude plums (greengages), fruit without yellowish rusty spots is selected. They are pricked on every side to the pit, and when softened by heating in plain water, the vessel is removed from the fire and a handful of salt and plenty of vinegar are added. One hour later they are replaced on the fire and well heated. When they come to the surface the fire is quickened, and when all have risen the vessel is removed and the contents are placed in fresh water. The salt and vinegar tend to give back their natural green colour. In the preparation of apricots and peaches, these are wiped with a cloth, then pricked, particularly in the unripened parts, and heated on a slow fire. As they rise and are found soft enough they are thrown into cold water. Fruit having first been softened must next be saturated with sugar. The material is first plunged into a weak syrup, which is concentrated gradually, with one day's interval between the degrees of concentration, according to the heat of the place where the operation is effected. It is sometimes necessary to have an interval of not more than twelve hours during the first few days, lest fermentation sets in. This is what is called to give the fruit a "façon." To give it a "frémie" means to put the material in its syrup upon the fire and leave it until the sugar approaches the boiling-point, in the meantime agitating the vessel occasionally. According to their nature, fruits are treated differently. Fruits with pits must be placed in thin syrup and receive a frémie before two days, after which they are cooked until the sugar has had time to penetrate everywhere. To prevent certain fruits from candying, and particularly such as are charged with gum, a little glucose is added to the last façon. With firm green fruits, the operation begins with a syrup of twenty-five degrees. The material receives from six to eight façons, the syrup being

strengthened each time by two degrees, and the last façon being made with a syrup of thirty-six degrees. Ripe and tender fruit is given a first façon in twenty-eight degree syrup, and is finished in a syrup of thirty-eight degrees. Only one façon per day must be undertaken, unless, under special circumstances (to prevent fermentation), two become necessary. Then it requires six days to complete the process. An ordinary façon lasts five minutes, during which the vessel is shaken occasionally. This period ended, the fruit is drained thoroughly, and the syrup being first skimmed is concentrated by two degrees and again poured over the material. When the last façon takes place care must be taken to allow the fruit to drain, after which it is allowed to rest for fifteen days. To obtain first-class preserved fruit the syrup should be changed after the fourth or fifth façon. If it becomes troubled, the beaten white of egg is added in a little water. No more syrup is employed at a time than is necessary to cover completely the contents of the vessel, as it seems to penetrate more readily. The "fruits glacés" are so prepared as to make them dry, agreeable to the eye, and easy to eat. To accomplish this, the "fruits confits" are drained and slightly washed with tepid water to remove the syrup remaining on their surface. Next, to "glacer" them, sugar is cooked until it bubbles. Into this liquid the fruit is dipped, removed, coated with sugar, and then placed on a wire netting. The glaçage should be thin and light like a varnish, it should bring the colour out and not hide it. Finally, the glaçage should be made at the last moment possible, as fruits are better preserved in syrup. As soon as fruits glacés are dry they are packed in boxes. The Consul states that he has not mentioned the dyeing processes, for the sufficient reason that fruit packers say no more about them than necessary. These processes are, however, said to be perfectly harmless. They certainly enable the packer to present a most attractive article. The delicious "marrons glacés" are not exported from France to far distant countries in any great quantities, on account of the difficulties of transportation. Neither are the dates stuffed with pistache cream, nor the "marrons fondés." Marseilles has always been famous for its fruits and bonbons, a generous rivalry prevailing between a number of the local makers of these articles to produce annually something new and interesting.

HOME INDUSTRIES.

The Cotton Trade Dispute.—It was almost incredible that there should be serious danger of a lock-out in the cotton industry, which might have affected some 200,000 workers, because four non-unionists were employed at the Yatefield Mill and twenty-eight union spinners objected, but none the less there was such danger. Happily a dispute which threatened to develop over the whole area of north and north-east Lancashire has been settled by the four non-unionists joining the spinners' organisation. The operative spinners of Lancashire are very strongly organised, and they look askance at men who, while they reap all the advantages gained by the influence of a trade union, refuse to pay the small weekly subscription to the union funds, and of late the policy of boycotting the non-unionists has been put into practice. The union men have won on this occasion, and they expect to win at other places where the same conditions exist.

Cotton Weavers.—Just now there seems to be a considerable shortage of cotton weavers. In several towns the lack of weavers has made it impossible to put in operation all the looms that have been either wholly or partially stopped during the depression of the last two or three years. Manufacturers in south Lancashire are offering to pay learners who will take up the work. In north and north-east Lancashire cotton-weaving has become so brisk that instances are cited in which girls of seventeen are entrusted with five looms, and are earning from 25*s*. to 28*s*. per week, whilst lads of fourteen are being put in charge of two looms. And it is likely that the lack of labour will be felt even more keenly in the immediate future, for new mills are being erected and old mills re-started, but it is probable that the shortage of labour will disappear when it becomes known that the improvement in trade is likely to be permanent. When trade is slack many operatives leave the manufacturing districts, and do not return until they can rely upon getting regular and remunerative work at the mills again.

The Single Payment Policy.—No one will question the immense benefits conferred upon the community by life assurance, but unfortunately these benefits depend very largely upon the assured retaining health and employment. A man takes out a policy and pays the premium upon it for many years, then illness, or loss of work, makes it impossible for him to continue paying, and he either allows it to lapse, or, if there is a surrender value, has to take less than a third of the actual money he has paid over to the company. In industrial assurance there is, as a rule, no surrender value, and all he can get (and he can only get that after he has been paying premiums for years) is a free policy for a small sum payable at death. Here is the weak point in insurance, and great numbers of the industrial poor suffer from it. For this reason the new departure made by the City Life Assurance Company should be welcomed. This company is now issuing what it calls "The Ideal Single Payment Policy," which gives whole life assurance for a single payment of £5. After the first payment nothing further is payable. The company keeps the policy in force, and in the event of the death of the policy-holder the company pays the full amount stated in the policy. Thus a young man of, say, twenty-one,

with an odd £5 to spare, takes out one of these policies, which assures him the sum of £15 at death. He has no further liability, and if next year he has another £5 to spare he can take out another policy assuring £14 14*s*., and so on from year to year. Or take a young woman of twenty-one. If she takes out one of these policies every year for ten years, she will have over £139 whole life assurance bought at a cost of only £50. The merit of the scheme is that the assured is guarded from loss through the mischances of life. He has paid his money once for all, and, come what may, the benefits of the policy remain to him. It will be surprising if this policy does not become very popular.

Railless Electric Cars.—The report of the deputation recently sent by the Edinburgh Corporation to inspect the railless electric cars of Leeds and Bradford, gives some interesting information respecting capital outlay and operating charges. In both towns the cars cost £700 each. At Leeds the capital outlay, which is mainly on overhead equipment, amounted to £1,246 per mile, and at Bradford to £1,734 per mile. The total operating costs, exclusive of interest and depreciation on capital outlay, in each case amount to 5½*d*. per car mile. The revenue, of course, depends largely upon the route, but at Leeds it amounts to about 8¾*d*. per car mile.

Oil Engines on Railways.—Last year the locomotive engineer of the North British Railway Company designed an electric locomotive with a steam turbine driving a dynamo, which in turn supplied electrical energy to electric motors, and now a leading British railway company has given instructions for the preparation of designs for a 500 h.-p. locomotive of a similar character, but using a Diesel engine for driving the dynamo instead of a steam engine. Commenting upon this new departure, a well-informed correspondent of the *Manchester Guardian* says that the results with the North British type of electric locomotive have not come up to expectations in the matter of economical working, owing to certain causes which were regarded as more or less likely when the experiment was embarked upon. The use of the Diesel engine, it is believed, will remove these difficulties, and at the same time reduce the size and weight of the locomotive, factors which will be of considerable importance in relation to the effect of such a type of engine upon existing permanent way, and also in the facility for negotiating curves at speed. If it can be demonstrated that the application of the internal-combustion engine for main line working is possible, a marked step in advance will have been made, as this method would not require any alteration of existing tracks or of telephonic or telegraphic local circuits, and would mean a considerable decrease in fuel, haulage costs, and water supply.

The Tonnage of Liners.—The growth in the dimensions of liners continues, and it looks as if Lord Pirrie's prediction that we shall see 1,000-feet ships will soon be realised. The Cunarder now being built at Clydebank is to have a length over all of 905 feet, which is 100 feet longer than the "Lusitania," and 20 feet more than the "Olympic." But the German "Imperator," now in course of construction in Germany for the Hamburg-America line, will have a length of 910 feet, with a tonnage of 50,000. Nor is it only steamers intended for the New York service that are growing in size. The new Allan steamers will be larger than the "Laurentic" and "Megantic," while the two liners being built for the Canadian Pacific Company's Vancouver-Hong Kong route will be larger in every respect than the company's well-known St. Lawrence "Empresses." But there is no similar advance in speed.

Domestic Service.—A committee has been appointed by the Women's Industrial Council with the object of improving domestic service as a career for industrial women. As a first step the committee will institute a widespread inquiry into existing conditions. A somewhat similar investigation was made about ten years ago, and the results were published by Miss Catherine Webb in the *Nineteenth Century* for June 1908, but little came of it. The conditions of domestic service are pretty well known, and the reasons why it is disliked. The reforms which are about to be suggested are in three directions: (1) Towards greater efficiency on the part of the employed; (2) towards their organisation and co-operation; (3) towards improved material conditions of service. No. 1 is desirable, but will hardly make the service more popular. No. 2 will be difficult to bring about. Something may be done in the direction of No. 3. There are many difficulties to be confronted. There is the notion among the artisan class that a girl who enters domestic service loses caste; there is the continuous service as contrasted with the comparative freedom of the outside worker, and there is the objection of the parents that the girl would earn more in, say, a factory, and that domestic service "doesn't put a trade into her hands when she marries." But nothing would be done in the way of social reform if the contemplation of difficulties prevented efforts at amelioration, and those who are tempted to question the possibility of raising the status of the domestic servant may profitably remember what has been done in that direction on behalf of the sick nurse.

CORRESPONDENCE.

DEW-PONDS.

The unusually dry summer which has just come to an end has afforded an excellent opportunity of testing the tradition that "dew-ponds" derive

their supply of water mainly from dew or mist, and never go dry.

Having taken a great interest in the investigations which have been in progress during the last three years, and the discussion in this *Journal* and other similar publications, I was curious to know how the ponds had fared. I wrote accordingly to the Royal Engineer officers under whose charge is that part of Salisbury Plain which is War Department property, to inquire. The report received states that "all dew-ponds in the Plain have gone absolutely dry this summer without exception."

The officer who kindly supplied this information adds that the ponds are generally, but not always, placed where they will take surface drainage, and consequently they received no doubt a certain amount of what little rainfall there has been. Perhaps some member of the Society who has had opportunities of observing the dew-ponds on the South Downs will be good enough to say what their case is.

WM. PITT (Colonel).

Enham House, Andover.
October 11th, 1911.

SLAG AND FURNACE REFUSE ORNAMENTS.

I notice in your correspondence a query by Mr. Ryle as to the glass ornaments made from slag. These were made when pressed glass first came in. The Gateshead Glass Works at Gateshead-on-Tyne is where they were made, and the owner of the works at the time, Mr. J. G. Sowerby, a perfect artist by intuition, made this and various other forms of glass-ware. His special Gateshead Art Glass was very much admired, and was really unique, until the German makers copied it badly and vulgarised most of it by careless repetition.

His artistic effects of colour were, however, obtained at a great sacrifice to the ordinary work, and many pots of metal (molten glass) were spoiled by endeavouring to get new effects of colour, etc. It was an interesting piece of work and very artistic, but had to be abandoned, like all truly artistic enterprises in this country—de Morgan tiles being another painful instance of insufficient appreciation.

E. E. PITHER.

Hampstead,
October 16th, 1911.

OBITUARY.

SIR WILLIAM JOHN CROSSLEY, BART.—Sir W. J. Crossley died on the 12th inst. at Manchester, after an operation. Born at Glenburn, in Ulster, in 1844, he was educated at the Royal School, Dungannon, and at Bonn. He entered the machine works of Sir W. G. Armstrong & Co., at Elswick, but at the age of twenty-three he set up, with his brother, the engineering firm Messrs. Crossley Bros., Ltd., in Manchester. They soon made a reputation as gas-engine manufacturers. In 1885 they won a gold medal offered under the Howard Trust by the Society of Arts at the International Inventions Exhibition for the "Otto" gas-engine, and in 1889 they were awarded another gold medal by the Society for a nine horse-power nominal "Otto" gas-engine.

Sir William Crossley found time for much public work. He became President of the Manchester Young Men's Christian Association, treasurer of the United Kingdom Alliance, chairman of the Manchester Hospital for Consumption and Diseases of the Throat, a member of the Cheshire County Council, and a Justice of the Peace for Manchester and Cheshire. He was one of the original promoters of the Manchester Ship Canal, of which he was elected a director.

As the Liberal candidate for the Altrincham Division at the General Election in 1906 he defeated Mr. Coningsby Disraeli, who had held the seat for thirteen years. In January 1910 he was again returned, but in the following December he was defeated by Mr. Kebty-Fletcher.

Sir William Crossley was much interested in the crusade against consumption, and he built and furnished at his own expense a sanatorium in Delamere Forest, Cheshire, for the use of patients from Lancashire towns. On this scheme he spent £70,000. In 1903 Manchester conferred upon him the freedom of the city in recognition of his public services, and in 1909 he was created a baronet.

He joined the Royal Society of Arts in 1884.

NOTES ON BOOKS.

THE PANAMA CANAL. By Harmodio Arias, B.A., LL.B. London: P. S. King & Son. 10*s*. 6*d*. net.

This volume, which forms No. 25 in the excellent series of monographs by writers connected with the London School of Economics and Political Science, is, as its sub-title states, a study in international law and diplomacy, and is an attempt to define the position of the Panama Canal under the law of nations. Mr. Arias has made a careful examination of the history of oceanic transit; he has traced the attitude of the United States of America towards the Canal question, and the variations that it has undergone in the course of years; he has discussed the later amplifications of President Monroe's message, "thus reviewing the diplomatic wrangles that have resulted from the attempt of the United States to apply to this question their famous doctrine in its advanced form"; and he has compared in an instructive way the legal positions of the Suez and Panama Canals. A useful appendix contains the different articles of the Clayton-Bulwer, Hay-Pauncefote and other treaties that bear directly on the matter.

The book is valuable because the expected opening of the Canal in 1915 will shortly make the

subject with which it deals of vital importance to most of the countries of the world. It is written in a clear and scholarly style, and gives a lucid account of an intricate and difficult problem.

THE TEN REPUBLICS. By Robert P. Porter. London: George Routledge & Sons, Ltd. 2*s*. 6*d*. net.

This little work is designed to serve as an introduction to a series of volumes on the Ten Republics of South America, and its appearance is opportune at a time when the commercial importance of these states is becoming every year more and more obvious. During the last ten years the trade of Latin America has increased by nearly £250,000,000, and its annual value is now estimated at £425,000,000. The United Kingdom can claim nearly one-third of the trade of the ten republics, so that their importance as a field for British capital can hardly be over-estimated. There seems little doubt, too, that this trade is capable of almost indefinite expansion, and that such expansion is bound to ensue as soon as the present difficulty—lack of means of communication—is done away with. On every quarter this appears to be the one bar to development. Brazil, for instance, in the first ten months of 1910, exported 31,494 tons of rubber, valued at over twenty-one million pounds; but, large as this amount is, it represents but an insignificant fraction of what might be obtained were it possible to get the rubber down to the coast from the inaccessible tracts in the upper valley of the Amazon. In the state of Minas Geraes, again, it is said that the iron ores form mountains rather than seams, but under present conditions this source of wealth is left practically untouched. Paraguay—to take a further instance—has some of the richest pasture and arable land in the world, but at present the cattle have to be driven such a distance that they are worn out before they reach a market; while the corn, which has to be carried in antiquated bullock-waggons, is rendered comparatively valueless by the cost and difficulty of transport.

Mr. Porter writes with a wide and accurate knowledge of South America, over the greater part of which he has travelled, and he is firmly convinced that, given increased railway communication, an enormous increase in the prosperity of the country may be confidently expected.

PAPERS ON INTER-RACIAL PROBLEMS. Edited by G. Spiller. London: P. S. King & Son. 7*s*. 6*d*. net.

This volume consists of the papers communicated to the first Universal Races Congress, which was held at the University of London last July, and they have been edited for the Congress executive by Mr. G. Spiller, the honorary organiser of the Congress. Many of the papers were reported at considerable length in the daily press at the time of their delivery, but it is extremely interesting to have them gathered together in one imposing volume. The papers are over fifty in number. They were all written with a view to encouraging between the white and coloured peoples "a fuller understanding, the most friendly feelings, and a heartier co-operation." The writers are of many nationalities and of all shades of complexion, but there is a strong similarity in their sentiments and in their ardent desire for the cause of peace and the welfare of the human race as a whole.

Many of the papers, such as Mr. Israel Zangwill's "The Jewish Race," the late Sir Charles Dilke's "Indentured and Forced Labour," Dr. W. E. B. Dubois' "The Negro Race in the United States of America," and the account of the North American Indians by one of them, Dr. Charles A. Eastman, are of great interest; indeed, the only fault one has to find with them is that, owing, no doubt, to the exigencies of the Congress, they are too short. Regarded as a whole, the book is remarkable, and its appearance should be welcome not only on account of the intrinsic value of most of the articles, but also on account of all that the volume symbolises.

GENERAL NOTES.

MEDICAL PRACTITIONERS IN GERMANY.—In 1910 the number of medical men practising in Germany amounted to 32,449, or five doctors for each 10,000 of the population, an increase of 480 over 1909. A still further growth may be expected, the number of medical students having risen from 9,239 in 1909 to 11,125 in 1910. The increase in the number of medical men was mostly in the cities—of the 480 additions, 329 went thereto. For every 10,000 inhabitants Berlin has 12 doctors, Wiesbaden 22, Munich 16, Stuttgart 10, Dresden 9, Leipzig 8, Chemnitz 5, Plauen 5, and Gelsenkirchen 4. The number of female doctors has risen from 55 in 1908 and 69 in 1909, to 102 in 1910. Of these Berlin has 32, Munich 6, Frankfort 6, Dresden 6, and Hamburg 4. The number of female medical students has risen from 371 to 512.

SWINEY LECTURES ON GEOLOGY.—A course of twelve lectures, on "The Natural History of Rocks," will be delivered by T. J. Jehu, M.A., M.D., F.R.S.E., in the Lecture Theatre of the Victoria and Albert Museum, South Kensington (by permission of the Board of Education), on Mondays and Tuesdays at 5 p.m., and Saturdays at 3 p.m., beginning Saturday, November 4th.

MEMORIAL TABLETS. — The London County Council have affixed a memorial tablet to No. 37, Chesham Place. This house was built by Lord John Russell, and occupied by him, with a few breaks, from 1841 to 1870, by far the most important period of his life. A tablet has also been affixed to No. 5, Great Stanhope Street, the residence for some twenty years of Lord Fitzroy

Somerset, Baron Raglan. It was from here that he set forth, in 1854, to take command of the British forces in the Crimea—an expedition from which he was never to return.

THE TURKISH TOBACCO INDUSTRY.—From various centres have come most favourable reports of the Turkish tobacco crop in 1910, which is said to be highly satisfactory. The exports to Europe and America in the fiscal year 1908-9 amounted to 58,000,000 pounds, and in 1909-10 to 70,000,000 pounds. These figures do not include the crop of 1910, or the exports to Egypt, which latter amount to about 8,000,000 pounds a year. There are indications that the present tobacco monopoly, whose thirty-years' concession expires in 1914, will not obtain a renewal of its contract with the Government, as the tobacco planters are vigorously protesting against the Régie's policy of restricting the production. The tobacco grown in and around Xanthi commands the highest price, that of Cavalla comes next, then follow those of Samsoun and Smyrna. In the district of Latakia, on the Syrian coast, is produced the unique product known to commerce as "Latakia tobacco."

THE ORIENTAL CARPET INDUSTRY.—The world's increasing demand for Oriental carpets has caused certain changes in the rug industry, particularly tending towards an enlarged output through the intervention of merchants in Constantinople and Smyrna, who are establishing factories of Persian carpets in both Turkey and Persia. Another new feature of the rug trade is the growing practice, on the part of merchants in Constantinople, of shipping direct—certainly to the United States—from Persia instead of from Constantinople. On the whole, Constantinople maintains its position as the world's principal rug market. Germany buys Oriental carpets in ever-increasing quantities in order to satisfy her own requirements, and those of Scandinavia, South America and Canada. Hamburg, being a free port, is becoming an important distributing centre for Oriental rugs. It is estimated that £1,718,000 worth of Caucasian and Persian rugs are shipped in a year from Constantinople and Smyrna, more than half of which go to Hamburg.

THE ECONOMIC CONDITION OF GERMANY.—An article on the economic, financial, and industrial condition of Germany at the present time, which has appeared recently in *Le Journal* of Paris, gives some interesting figures to prove that the country is in a far more prosperous condition than the majority of people in France suppose. The writer, who bases his assertion on data published in the *Statistiches Jahrbuch*, says, in the first place, that the population of the German Empire has increased during the last thirty years from forty-five millions in 1880 to sixty-five millions in 1910. The production of coal has increased from 53,471 tons in 1880 to 834,000 tons in 1909; iron and steel from 1,548,000 tons to 7,373,000 tons during the same period; the number of workmen from 7,431,000 to 11,348,000. The exports and imports, which amounted in value to 5,712 million of marks (£285,600,000) in 1880, now exceed the sum of 15,000 million marks (£750,000,000) annually. Thirty years ago 46,000 vessels, of an aggregate tonnage of seven millions, entered the German ports; they now number no fewer than 95,322, of 25,418,000 tons. The number of German-owned steamers has increased from 414 to 1,950, and their total tonnage from 216,000 to 2,350,000 tons. The gross receipts of the German railways, which in 1880 were 886 million of marks (£44,300,000), amounted in 1908 to 2,420 million of marks (£121,000,000). In 1880 the total amount deposited at the savings banks throughout the country was 2,614 million of marks (£130,700,000), which had increased in 1910 to 61,053 million marks (£3,052,650,000). The amount of the deposits at other banks all over the country has increased in a similar proportion.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, OCTOBER 23...Farmers' Club, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mr. C. Kains-Jackson, "The Metric System as applied to Agriculture."

Sanitary Engineers, Caxton Hall, Westminster, S.W., 7.30 p.m. Mr. Percival M. Fraser, "The Parliamentary Bill on 'Sewers and Drains.'"

East India Association, Caxton Hall, Westminster, S.W., 4 p.m. Mr. Oliver Bainbridge, "Some Anglo-American Impressions of India."

TUESDAY, OCTOBER 24...Zoological, Regent's Park, N.W., 8.30 p.m. 1. Mr. Edward G. Boulenger, "On a new Tree-Frog from Trinidad, living in the Society's Gardens." 2. Mr. Bruce F. Cummings, "Distant Orientation in Amphibia." 3. Mr. Oldfield Thomas, "The Duke of Bedford's Zoological Exploration of Eastern Asia.—XV. On Mammals from the Provinces of Sze-chwan and Yunnan, Western China." 4. Mr. E. P. Stebbing, "Game Sanctuaries and Game Protection in India."

WEDNESDAY, OCTOBER 25...United Service Institution, Whitehall, S.W., 3 p.m. Captain E. Rason, "History of the Communications between Russia and England."

Royal Society of Literature, 20, Hanover-square, W., 5 p.m. Professor R. P. Cowl, "Some Aspects of the XVIII. Century Poetry in the Light of XVIII. Century Critical Theory."

THURSDAY, OCTOBER 26...Concrete Institute, 296, Vauxhall Bridge-road, S.W., 8 p.m. Mr. R. L. Humphreys, "Fireproofing."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. A. Cheese, "A Winter Holiday in Greece."

FRIDAY, OCTOBER 27...Physical, Imperial College of Science, South Kensington, S.W., 5 p.m. 1. Hon. R. J. Strutt, "Further Observations on the Afterglow of Electric Discharge and Kindred Phenomena." 2. Professor C. G. Barkla and Mr. J. Nicol, "Homogeneous Fluorescent X-radiation of a Second Series."

SATURDAY, OCTOBER 28...Educational Handwork Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 3 p.m. Lecture by Mr. B. P. Ballard.

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FRIDAY, OCTOBER 27, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

ROCK CRYSTAL: ITS STRUCTURE AND USES.

By Alfred E. H. Tutton, M.A., D.Sc., F.R.S.

Lecture IV.—Delivered May 22nd, 1911.

The applications of quartz to both scientific and artistic purposes, as well as to industry, are so numerous and varied that a separate lecture may well be devoted to them, and can, indeed, by no means exhaust them.

The coloured varieties of transparent quartz crystals have since very early times been highly valued as gem-stones, and of these amethyst, which proved so interesting on investigation in the last lecture, is, perhaps, the most important. The violet colour, its great attraction, is due to a minute trace, so slight as to be almost chemically undetectable, of an oxide of manganese, which appears to be concentrated between the lamellæ. It was shown in the last lecture that the violet colour is usually only developed in alternate sectors of about 60°, which are revealed with great clearness when a section-plate is cut perpendicularly to the axis, for polariscopical investigation, and that the lamellar twinning is exhibited chiefly in the parts which are thus naturally coloured violet. A very fine example of such a section-plate, three inches in diameter, is exhibited on the lecture table, and a photograph of it on the screen. The violet sectors usually close up near the centre, so that the whole of the central part of the crystal is violet-coloured and composed of rapidly repeated twins. This part, moreover, exhibits no trace of optical activity in parallel polarised light, and affords the ordinary uniaxial interference figure in convergent polarised light, the black cross being complete right up to the centre; for the two varieties of quartz, right- and left-handed, are so intimately blended, that any effect due to the one is neutralised by an equal and opposite effect due to the other, affording a beautiful illustration of the property of pseudo-racemism, alluded to in the last lecture, on the large scale.

But it must not be taken for granted that this interesting lamellar twin structure in quartz is confined to violet crystals, and altogether to the violet sectors; for many crystals show it which are either perfectly colourless, or slightly yellow, or which only show a faint trace of the violet colour when held up to the light. If a trace of colour be present, however, the twin lamellæ are usually just perceptible even in ordinary light, when the section is regarded at some particularly suitable angle. Amethysts, and, in fact, all quartz crystals showing the laminated structure, break with the well-known "ripple" fracture. An interesting theory has been put forward by Professor Judd that the lamination is due to the movement of the molecules of the alternate layers along glide planes, and he has shown that quartz does possess such planes of possible gliding, parallel to the rhombohedral faces. Such gliding, when carried out above a certain limit, results in permanent inversion of the positions of the molecules, and this could well be effected by the simultaneous action of high pressure and temperature, subsequent to the formation of the original crystal. For there is considerable evidence that the purple tint was developed subsequently to the first crystallisation, and that it was due to a change in the state of oxidation of the manganese, probably as the result of the physical forces at work in effecting the gliding of the molecules of alternate laminæ.

When the colour of quartz is yellow, it is usually due to a trace of ferric oxide. The bright topaz-yellow crystals are usually known as "citrine," and those not so brightly yellow, and also those possessing a brown appearance, are included under the name of "cairngorm," a

name derived from the locality (Banffshire) in Scotland where some of the finest specimens have been found. It is very interesting to read in "Leaves from the Journal of Our Life in the Highlands," by her late Majesty Queen Victoria, that on several occasions the late Prince Consort, who took so keen an interest in everything pertaining to natural knowledge, and who was himself a very good mineralogist, discovered and brought to her Majesty beautiful specimens of cairngorm and of other varieties of rock crystal, or suggested to the party a search for such crystals, which eventually proved successful, during their delightful rambles among the glens and mountains around Balmoral. We find, for instance, in the account of the ascent of Ben-na-Bhourd, that near the top "We came upon a number of 'cairngorms,' which we all began picking up, and found some very pretty ones"; also that during the return journey "Albert found some beautiful little rock crystals in the Sluggan." Again, on the occasion of the ascent of Ben Muich Dhui, "We all began walking and looking for cairngorms, and found some small ones."

These reminiscences of the Prince Consort, who was one of the best friends of the Royal Society of Arts, will doubtless afford particular pleasure in this place. They once more emphasise the great loss that Science in this country suffered in the premature demise of one who was so rapidly developing the means of effectively spreading abroad amongst our people both the taste for and the means of cultivating the knowledge of science, and who realised so deeply its immense influence on industry and on the well-being of the country.

The darker varieties of brown or brownish-yellow crystals, and also all black crystals of quartz, are included under the name "smoky quartz," although the special name of "morion" has been given to the beautiful black crystals lining cavities in granite in the Mourne Mountains of Ireland. The beautiful pale rose-coloured quartz, so valued as ornaments, and which is associated with manganese minerals in masses of granite in Bavaria, like amethyst, is supposed to owe its colour to oxide of manganese, and the fact of this association with manganese minerals is strong presumptive evidence that the conclusion is correct.

The name amethyst was given to the purple variety of quartz crystals, according to Pliny, from the belief which was rife among the Greeks that the possession of the stone was a preventive against intoxication by the purple wine cup, being derived from ἀμέθυστος. Plutarch suggests, however, that the name is connected with the colour of amethyst; for if the purple wine be watered down to the colour of amethyst it is then too weak to intoxicate. It was greatly valued by the Greeks and Romans as a gem-stone, but the discovery of such large quantities in Brazil, Ceylon, and Siberia in recent times has reduced its market value, a result which has been also aided by the ease with which coloured glasses of similar tint can now be made. Indeed, so long ago as the year 1690 very good imitations were produced in France, which, in the absence of accurate knowledge of the optical properties of quartz, were almost impossible to be distinguished from true quartz amethysts.

It is deeply interesting to recall that rock crystal was so well known to the ancient Egyptians, and even to the Hittites, Assyrians, and Babylonians, that necklaces, seals, and engraving cylinders were quite in common use, and are now frequently discovered by Egyptologists and other archæologists. We are informed by Mr. C. W. King, in his fascinatingly interesting "History of Decorative and Ornamental Stones," that the earliest known work on such stones is that of Theophrastus, who wrote in the fourth century B.C., and that he refers to rock crystal as being greatly used for decorative purposes in his time. The Romans, however, were successful in discovering such large and perfect crystals, as their empire extended, that it was quite the fashion to use cups and vases of carved quartz for their iced drinks and floral displays, and fabulous sums are recorded as being given for the best of these lovely objects of art. For instance, Pliny tells us of a lady of the less opulent class who gave the Roman equivalent of £1,500 for a carved bowl of rock crystal. The story of Nero in one of his rages smashing two priceless bowls of quartz, engraved with designs from Homer, is also well authenticated. Perhaps one of the most curious stories from Roman life, however, is that told by Seneca, concerning Vedius Pollio, a wealthy Roman, who had been so fearfully enraged by one of his boy slaves having broken a crystal vase that he ordered the boy to be thrown into a lamprey pond, to be eaten alive. The boy escaped and sought the Emperor Augustus, to whom he petitioned for a less horrible death. Augustus was so struck with the cruelty of the sentence that he ordered the boy's release, and that all Pollio's collection of vases and cups of rock crystal should be broken

in pieces, and that the lamprey pond should be filled up.

As the luxury of the Romans increased, and larger and larger crystals were discovered, the vases and other objects of art carved from them became embellished with raised mouldings, and engraved with foliage and flowers, and with the figures of animals, deities and men and women. Lucius Verus is said to have possessed a crystal bowl so large that no man could be found to quaff the whole of the contents at one draught; and a still more remarkable story is told by Mohammed Ben Mansar of a merchant in Mauritania possessing a basin composed of only two pieces of rock crystal, and which was so large that four men could sit in it at once. Doubtless this is somewhat of an exaggeration, but Mr. King informs us that in the treasury of Ghisneh, when captured in A.D. 1159, four crystal vases were found, each of which would hold two skins of water.

It is a well-known fact that at many Roman feasts the crystal cups were retained by the guests, a perfectly vouched for instance being at the wedding of Caranus, when each guest was presented with the Murrhine or Alexandrine rock-crystal cup from which he drank the health of the bride and bridegroom. Also at the celebrated dinner given by Lucius Verus, which is estimated to have cost £60,000 of our money, the party being only twelve in number, after each course both the crystal cups and the plate, and also the slaves who waited upon the party, were presented to the fortunate guests.

In the later periods of Imperial Rome, quartz rings, carved from the solid crystal, were very much worn, and the Arabs became very expert in the art of working these rings out of rock crystal. When we remember that the hardness of quartz is 7° in the scale of hardness, that is, that quartz is as hard as or harder than steel, and that only topaz, corundum, and diamond are harder, we may wonder at and admire the more the extraordinary skill of these early carvers. The largest mass of quartz recorded as being ever seen by the Romans was the ball of quartz, 50 lbs. in weight, which was dedicated in the Capitol by Livia. A bowl which held two quarts is also referred to as having been in use at the same time. Spheres of crystal are not infrequently discovered amongst much earlier remains, for instance at Nineveh, where they were used as burning-glasses. In Roman times such spherical lenses were employed by surgeons for cauterising wounds, and Pliny says: "I find it asserted by surgeons that when any part of the body requires to be cauterised it cannot be better done than by means of a crystal ball held up to the sun's rays." Balls of crystal were also greatly valued for another remarkable property of quartz, which has not yet been referred to, namely, its extraordinary coldness to the touch. It was quite a customary thing for a wealthy person to hold a ball of quartz in the hand during the heat of midsummer, its refreshing coolness being most grateful. Mr. King gives two quotations from Propertius which express this fact quite clearly :—

"Oh what avails the purple's Tyrian glare,
Or that my hands the limpid crystal bear?"

"Now courts the breeze with plumes of peacocks fanned,
Now holds the flinty ball to cool her hand."

In the mystical writings attributed to Orpheus by the religious cult founded in his name are found several allusions to crystal spheres. A ball of rock crystal is recommended as the most proper means of kindling the sacrificial fire, the sphere being thus used as a burning-glass, a spherical lens in fact, and the fire thus produced was known and venerated as the "fire of Vesta."

There was a long interval during the dark ages following the break-up of the Roman Empire when we hear little of the uses of rock crystal. But with the Renaissance came a remarkable revival of artistic work in quartz. This material was employed for the most important intagli, caskets, medallions, and plaques. For instance, one of the principal works of Valerio il Vincentino was a coffer adorned with plaques of crystal portraying the history of the Passion, which he was commissioned by Clement VII. to prepare at the price of 2,000 gold scudi as a present for Francis I. Michael Angelo also prepared numerous designs for plaques of rock crystal. Moreover, the construction of crystal vases was resuscitated, and there is an actual inventory in existence of the works of art in rock crystal which had been accumulated by the French monarchs up to the fatal year 1792, which places their value at no less than £40,000. The Milanese in particular distinguished themselves by their skill in crystal cutting, and the names of Ciuliano Taverna and Annibal Fontana stand out prominently as masters in the art of making intagli and cameos; there is a record of the latter having constructed a crystal coffer for the Elector of Bavaria, for which he received 6,000 scudi.

By the very great kindness of my friend Mr. Alfred Simson, I am enabled to exhibit on the lecture table nine exquisite examples of

this ancient and revived art. The most antique, and possibly the most interesting, is a Buddhist reliquary from Ceylon, probably from Anuradhapura. Its probable date is about 300 B.C., or possibly a little later, and it is supposed to have once held a relic of the Buddha, Gautama. In general appearance it is not unlike a specific gravity bottle of larger size than usual, and it is ornamented with mouldings around the body and the stopper.

We have next a large bust of Augustus Cæsar, measuring 15 ins. by 10 ins., carved out of a single crystal, its period, unfortunately, not being known. Then we have a large crucifix, over a yard high, of rock crystal mounted in silver, the ends being engraved with religious figures. The cross stands on a skull, which surmounts a large block of crystal upon which are engraved emblems of the Passion. We have next four exquisite cups, two of them possessing carved covers. One of these cups is reproduced in Fig. 37; it takes the form of a conventional bird, driven in jewelled harness by a figure seated on the cover. It is of Austrian workmanship of the last century, and is mounted in silver-gilt and bejewelled with pearls, emeralds, and rubies, the crystal bird having a crown on its head besides being richly engraved. The second covered cup, represented in Fig. 38, takes the form of a nautilus. The cover bears the figure of a horse, and the prow-like front is surmounted by a child's head. It is also mounted in silver-gilt and adorned with numerous jewels, the crystal cup itself being deeply cut in relief with nautilus scrolls and mouldings. The other two are uncovered cups of German workmanship, enamelled and jewelled. One of them has a dragon for handle, enamelled in dark green and with the head projecting over the centre of the cup. The other, shown in Fig. 39, is of shell-form, and is mounted in silver-gilt and enamelled and jewelled. The diameters of these four cups vary from 7 ins. to 16 ins. There is also exhibited a plaque of quartz, nearly 7 ins. by 5 ins., engraved with figures of Christ and the Virgin, and possessing a richly carved and moulded rim, the plaque being of elongated octagonal shape. Also a tray is exhibited, 11 ins. by 9 ins. in size, of wonderfully clear quartz, of Indian workmanship, and engraved with a leaf design.

FIG. 37.—QUARTZ CUP IN THE FORM OF A BIRD, WITH COVER.

Besides these lovely objects of art on the table, we are enabled, by the kindness of the Keeper of the Rothschild Collection in the Waddesdon Room of the British Museum, to project on the screen lantern-slides of six exquisite specimens there exhibited. The most imposing is a two-handled covered cup 11 ins. high, of sixteenth-century German workmanship. It is mounted in gold, and enamelled and set with numerous jewels. The handles take the form of dolphins, and the

FIG. 38.—NAUTILUS-SHAPED COVERED CUP OF QUARTZ.

cover represents a stork with ruby eyes and with a gold collar round the neck. The bowl itself is of oval shape, and is engraved with representations of the triumph of Galatea. The foot in two stages is engraved with the figures of marine deities. The mounting is very rich, the general plan being an oblong fret in white enamel, each oblong enclosing an enamelled fruit, or a ruby or diamond, together with a gracefully looped cord, the loops being of ruby or emerald-coloured enamel.

The next in importance is a two-handled vase and cover of rock crystal, in the form of a compressed sphere, mounted in gold and also richly enamelled and jewelled. The sides are engraved with slender plants hanging from the top or springing upwards from the base. On one side is engraved a pear-shaped cartouche, with the name Akbar in Arabic characters. The scroll handles are carved with groups of fruit, and the base is cut in radiating gadroons, while the mount has four feet in scroll work and fruit, enamelled and set with four diamonds. This also is said to be sixteenth-century German work, although there are indications that it may be of Indian workmanship but reset in Germany.

We see next a lantern-slide of a ewer of rock crystal, the mouth and shoulder being in one piece, and the latter being engraved with vines and birds, while the lower part of the body, in another piece, exhibits figures of Neptune and sea-nymphs, beneath festoons. The upper and lower parts are held together by a broad gold band, with rubies and diamonds set in high relief alternating with groups of fruit in enamel. The mouth takes the form of a half-length lion with enamelled wings, and the stem and handle are also richly designed and carved and set with rubies and diamonds.

We next have a tall cup with cover, the body being bell-shaped and richly carved with deeply-cut diagonaled lines; the foot is ornamented with dragons and the cover surmounted by a wyvern. The whole is 10 ins. high, and came from the collection of Count Nostitz, of Prague.

The next slide represents a slender elongated bowl of rock crystal of Italian workmanship, also sixteenth century. The bowl is a narrow oval, curved inwards at four points where the engraving represents entwined dragons. The rest of the bowl is ornamented with acanthus leaves springing from the stem. The baluster stem is also of clear crystal filled in with black and translucent enamels. The foot bears an acanthus quatrefoil in relief. This object is altogether one of the most graceful and elegant examples of work in rock crystal.

The last of these slides represents a plaque of quartz oval in shape and engraved in intaglio,

FIG. 39.—SHELL-LIKE QUARTZ CUP, UNCOVERED.

the subject being a deeply interesting one; for it is a copy of the fresco of the Sale of Cupids discovered at Herculaneum in June, 1759. The rim is mounted with gold, which is enamelled with studs and bands. The size of the plaque is 6 ins. by 5 ins.

Besides works of art in the form of useful objects and ornamental plaques, of which we have now seen some of the best examples, another use for quartz in the later Middle Ages, and even in more modern times, has already been alluded to, namely, for the construction of spherical balls for mystic and occult purposes. Two fine examples of such spheres of rock crystal are exhibited on the table, by the kindness of Mr. Henson and of Mr. Gregory, to the latter of whom, and to Mr. Butler, the lecturer is also greatly indebted for the excellent crystals of quartz with which these lectures have been illustrated. The balls are respectively of 4 ins. and 3 ins. in diameter.

A very famous sphere of rock crystal was the "show stone" of the celebrated Dr. John Dee, who, in the middle of the sixteenth century, was a Fellow of the then newly-established Trinity College, Cambridge. Dr. Dee lived through the reigns of Henry VIII., Edward VI., Mary, Elizabeth, and James I., and his literary and scientific writings are a most extraordinary mixture of fact, imagination, and mediæval astrology, while his reputed doings were often of the kind bordering on charlatanism and conjuring. He was frequently consulted as to the coming fates of his clients, and the crystal sphere was his chief stock-in-trade on such occasions. He died at Mortlake in the year 1608, at the ripe age of eighty-one.

The *modus operandi* of "crystal-gazers" is very various, but a common method is to support the sphere on an annular stand, the ring being just small enough to prevent the ball from falling through it, thus enabling the gazer to see right through the ball to the table below, which is generally darkened. Another favourite method is to hold the sphere in both hands, so as to avoid reflections. The observer sits with his back to the light, and gazes intently into the sphere, trying to think of nothing in particular and to be oblivious of surrounding objects. Five to ten minutes, or possibly sometimes longer, suffice in the case of a good "medium." The lecturer is assured on the authority of one well versed in the subject that it makes a great difference whether the ball be of real quartz or of glass, and has gathered the impression that the double refraction of quartz has something to do with this difference. Some very remarkable stories have been told of things thus seen, apparently in the sphere, but doubtlessly subjectively in the mind's eye, whatever that expression may mean, and statements are often made that events have actually occurred exactly as seen in the crystal globe. The lecturer has had no personal experience of these remarkable occurrences, but would be the last person either to deny what he has no exact knowledge of, or to assert their absolute trustworthiness as natural phenomena. He will content himself by saying that it is quite certain that we do not yet realise or know, or least of all understand, many of the forces and phenomena at work around us in nature. As Hamlet so truly says: "There are more things in Heaven and earth, Horatio, than are dreamt of in your philosophy."

We next come to an interesting fact about quartz, which has already been alluded to in passing, namely, its coldness, which is an excellent and immediate test as to whether an object be of quartz or only of glass. This property it owes to its high thermal conductivity. Quartz is a better conductor, according to Tyndall, than bismuth, lead and several other metals, and very much better than gypsum and most other transparent minerals. Sand, however, which, as we have seen, is quartz in a state of fine division, is a bad conductor merely because of its discontinuity, for each grain separately is a good conductor through its own substance. De Senarmont showed long ago that the conductivity is greater along the axis of the quartz crystal than perpendicularly to the axis. If two plates be cut, one parallel and the other perpendicular to the axis, and if, further, a fine hole be bored through each and a hot wire be stuck through a coating of wax laid over, the plate will melt around the wire in an ellipse in the case of the former plate, the longest diameter of the ellipse being parallel to the axis, while the wax will melt in a circular patch in the case of the plate cut perpendicularly to the axis. Spectacle-makers are well known to discriminate between quartz and glass lenses by the cooler feel of the former on applying the two in turn to the tongue.

This brings us to one of the most important of the applications of quartz, namely, the construction of lenses. Quartz spectacle lenses are much more permanent, less breakable, than glass ones, and provided they are constructed so that the axis is perpendicular to the tangent planes to their surfaces of curvature there is no appreciable double refraction introduced. For

the amount of the double refraction of quartz has been shown to be fortunately very small. The name "pebbles" has come to be given to quartz spectacle lenses from the fact that the quartz crystals used for the purpose of making spectacles come chiefly from Brazil, where they have been rolled over one another in loose heaps, or in the beds of mountain streams, for years and possibly ages, and so have become rounded into pebbles. They come mostly from the states of Goyaz, Minas Geraes, Bahia, and Rio Grande do Sul.

But besides the commercial use in spectacle-making, the construction of quartz lenses has now a very high scientific value, inasmuch as quartz is remarkably transparent to the non-visual rays of shorter wave-length than those of violet light, the so-called "ultra-violet rays," and also to certain waves of longer wave-length than those of red light, the "infra-red" of the spectrum, although in this latter case there are more absorption gaps. Practically all glasses absorb most of both the ultra-violet and infra-red rays, so that a train of quartz lenses and a quartz prism or prisms is an absolute essential for the spectroscopic study of these rays lying outside the visible spectrum. There is on the table a very fine spectroscope with complete quartz train of lenses and prisms, designed for this purpose, and constructed by Messrs. Hilger. The large 60°-quartz prism is of the kind recommended by Cornu, being composed of two 30° prisms, not cemented together by balsam but adhering firmly in contact owing to the true planeness of the surfaces; one is cut from a right-handed crystal and the other from a left-handed one, the optic axis being perpendicular to the junction-plane in both cases. By this device all optical activity (rotation) is neutralised and eliminated.

Still another scientific use for quartz has been found in the construction of standard weights. By the kindness of the Deputy Warden of the Standards, Major P. A. MacMahon, F.R.S., I am enabled to exhibit a set of standard weights belonging to the Standards Department of the Board of Trade, constructed from perfect crystals of quartz, no single flaw being anywhere discoverable. The largest is the standard kilogram. It was constructed, along with the smaller weights of the set, for the Standards Department by Dr. von Steinheil at Munich, in accordance with the recommendations of the Standards Commission. The crystal of which the kilogram was made was a Brazilian pebble of large size and nearly globular, which was procured by Mr. James Simms. The axis of the cylinder of each of the weights is parallel to the optic axis of the crystal from which it was cut. The density of the specimen, as determined by Dr. von Steinheil, was 2·65096. The great advantage claimed for this standard kilogram of quartz was that its weight remained constant, whereas metallic weights varied from time to time to a slight degree. Indeed, Dr. von Steinheil went so far as to say that "quartz alone maintains its weight invariable under all circumstances." Reversion has, however, recently been made to platinum-iridium as a more suitable substance for standard weights.

Another important scientific use was in the construction of an interference tripod of quartz, by Reimerdes at Jena, to replace the platinum one used by Fizeau in the well-known interference method of determining thermal expansions which was devised by Fizeau. It may be remembered that an improved Fizeau apparatus, which introduced the micrometric measurement

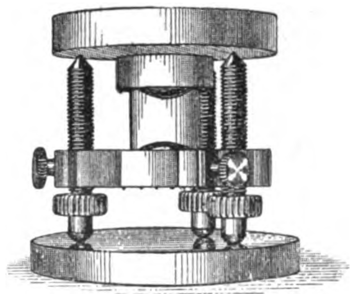


FIG. 40.—INTERFERENCE TRIPOD OF PLATINUM-IRIDIUM.

of rectilinear interference bands, instead of the use of curved fringes and signal points of reference which they were made to pass, was devised by Abbe and perfected by Pulfrich; and also that a still more convenient form was subsequently described by the lecturer. The tripod employed in the latter apparatus was constructed of platinum-iridium, and is represented in Fig. 40. The figure actually shows the arrangement used in determining the thermal expansion of a piece of porcelain tube, the latter being laid on the table of the tripod and covered with a disc of aluminium; the upper surface of the latter and the under surface of the large glass plate laid over the screws are the two surfaces which are caused to reflect the interfering light. The quartz arrangement as employed by Reimerdes at Jena with the Pulfrich dilatometer is shown in Fig. 41, *R* being the essential part, namely, a ring of quartz,

very much like that of porcelain shown in Fig. 40, cut from a plate a centimetre thick perpendicular to the axis of the crystal, and hollowed out somewhat so as to leave three places only on each surface, above and below one another, of the original thickness, in order to obtain the desirable three-point contact only with a ground-plate *G* and a cover-plate *D*, also both of quartz. The under surface of the upper plate bears a little silvered circular spot or ring, *m*, as a reference mark for observing the passage of the interference bands. The possibility of any reflection from the upper surface of the lower plate is avoided by matt-grinding, and the reflection from the upper surface of the cover-plate is eliminated sideways by making the two surfaces

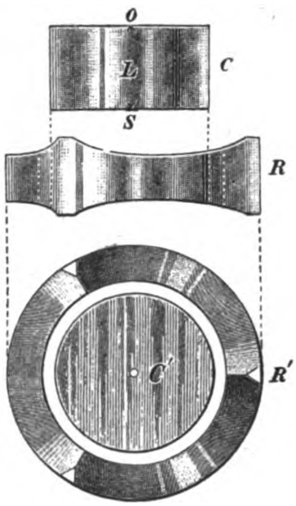
The value obtained by Reimerdes for the direction of the axis, as directly afforded by his quartz tripod, was :—

$$a = 10^{-8}(692 \cdot 5 + 1 \cdot 689t).$$

The coefficient of linear expansion along the axis is thus only half as much as that at right angles to the axis. The value for the axial direction is slightly less than that of platinum-iridium, which is 10^{-9} $(8600 + 4 \cdot 52t)$.

The advantages claimed for quartz as the best substance for an interference tripod are, that it is quite free from thermal lag or secular change, very regular in its change of expansion with the temperature, that the value is independent of the locality from which the quartz crystal is derived, and that quartz possesses greater hardness and more perfect elasticity than metals.

We now come to the last of the properties of quartz which can be touched upon in these lectures, but one which has extended its industrial use to an extent which is only just



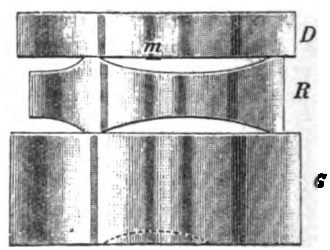


Fig. 41.—Tripod of Quartz Interference.

of the plate to be inclined at the small angle of 20 minutes out of strict parallelism, thus leaving the reflection from the under surface of the cover-plate alone visible. The second reflecting surface concerned in the interference is that of the object under investigation itself, which is of slightly less than 10 millimetres thickness and small enough in lateral dimensions to be placed within the quartz ring.

The coefficient a of the linear thermal expansion of quartz, as determined by Benoit with the Fizeau apparatus at Sèvres, for the respective directions of the axis and of the perpendicular thereto, are as under :—

For the direction of the axis

$$a = 10^{-8}(711 \cdot 1 + 1 \cdot 712t).$$

For that perpendicular to the axis

$$a = 10^{-8}(1316 \cdot 3 + 2 \cdot 526t).$$

beginning to be realised, namely, the fact that at the temperature of the oxy-hydrogen blow-pipe flame it fuses, and on resolidification forms a clear colourless glass of remarkable properties. The chief of these are that the transparent material thus obtained is almost unbreakable, that it will withstand sudden changes of temperature such as would at once shatter any glass, and that it possesses an elasticity which is well-nigh perfect, besides being an almost perfect electrical insulator, only wetting in contact with water with the greatest difficulty, and thus not attracting moisture at all. Quartz was first fused, as far as we are aware, by Gaudin in the year 1839, but it was Professor C. V. Boys who first acquainted us with the properties of fused quartz, in the celebrated research on the Cavendish experiment, for which he required a perfectly elastic suspension fibre, and found it in fused

quartz. It will be well remembered what interest was created by his exhibition of the production of such quartz fibres, by fusing a quartz crystal, attaching the viscous material to an arrow, and shooting the latter from a bow and thereby producing a quartz fibre as long as the room, both in this lecture theatre and at one of the conversazioni of the Royal Society some years ago. The fact that such a fibre of fused quartz is perfectly elastic rendered it an ideal filament for the suspension of his small golden spheres (attracted by larger leaden ones) in the Cavendish experiment, which enabled him to obtain the most accurate value yet arrived at for the density of the earth, namely, 5·5268.

For it was shown that two small spheres having a mass of one gramme each, when placed so that their centres were one centimetre apart, attract each other with a force of $6 \cdot 66 \times 10^{-8}$ dynes (the centimetre-gramme-second unit of force being termed a dyne), and this corresponded to the density of the earth just given. Quartz fibres also proved of inestimable service in Professor Boys' well-known radio-micrometer.

Fused silica glass is now a commercial material, being supplied on a considerable scale by the Silica Syndicate of 82, Hatton Garden, London, in a beautifully transparent form, and by the Thermal Syndicate of Wallsend-on-Tyne in an opalescent form, produced by means of the electric furnace, which is cheaper while being still fairly pure, the opalescence being due to the presence of air bubbles, from which the material of the Silica Syndicate is remarkably free. Silica glass is also made by two firms in Germany. By the kindness of Messrs. Johnson and Matthey, and of Messrs. Griffin, a large and typical collection of articles constructed of these two varieties of silica ware is exhibited on the lecture table. For such skill has now been acquired in the working of large quantities of quartz fused by the oxyhydrogen flame or in the electric furnace, the new implement of high temperature research and industrial progress now available, that most of the usual laboratory articles required by the chemist and physicist can be made in this highly refractory material. Quartz begins to soften at a temperature of 1500° to 1600° C., in the neighbourhood of the melting-point of platinum, and can be worked by skilled men at temperatures somewhat higher. Such apparatus of fused silica is almost indestructible, for it withstands sudden heating or cooling (such as heating to redness and then suddenly plunging into cold water) in a remarkable manner, and is well-nigh unbreakable, except by the use of quite unusual force, an ordinary fall on the floor rarely injuring it.

It is interesting that when quartz (specific gravity 2·651) is fused, the solidified cooled glass has only the specific gravity 2·21, there being thus a considerable reduction of density. Crystallographically this is important, as it shows that the molecules of silica are much more closely packed in the crystal than in the silica glass. Also the index of refraction is correspondingly lowered by fusion of quartz, that of the glass being 1·4585 (Gifford and Shenstone), whereas the two refractive indices of the crystal are $\epsilon = 1 \cdot 5534$ and $\omega = 1 \cdot 5443$. The reduction on fusion is in accordance with Gladstone's law, the specific refraction, which takes into account the density, remaining constant. Also the coefficient of expansion is remarkably reduced, for whereas that of quartz for the direction of the axis, the minimum expansion, has been shown to be 0·00000711, that of fused silica has been independently shown by Callendar and Minchin to be less than a tenth of this, the results of the two researches being 0·00000059 and 0·00000045 respectively.

For delicate operations in the laboratory silica glass is proving an inestimable boon, being far less readily attacked by acids (other than hydrofluoric) and other reagents than ordinary glass or porcelain. It is particularly suitable for the construction of weights, thermometers, vapour density apparatus, pyrometers, and all kinds of thermometers for ordinary purposes.

Moreover, it is now coming into use in metrology, and by the kindness of the Director of the National Physical Laboratory it is possible to exhibit a lantern-slide picture on the screen of a standard metre bar which has lately been constructed for the laboratory by the Silica Syndicate. Owing to its very small coefficient of expansion, and its constancy and durability, fused silica would appear to be particularly suitable for the material of a standard of length, provided experience should show that it is not subject to irregular secular change. There is practically no hysteresis within any possible range of temperature to which a standard of length would be subjected, direct experiments having established this fact satisfactorily. The standard takes the form of a transparent silica tube about two centimetres in diameter and a metre long, which merges at each end into a clear transparent horizontal slab of silica for the engraving of the reference lines. A silica knife-edged trunnion is fused into the bar at one

of the usual "Airy points" of support (those for which least flexure occurs), somewhat removed from the ends, the other point being indicated by a ring etched round the tube. The tube is thus a closed one, but it is pierced by two holes to permit of its submersion in water for temperature equalisation purposes. The reference lines are cut in a hard, closely adhering film of platinum, deposited on the silica, and protected by a cover slip. The reference lines are viewed and their positions read from the other side of the slab, the platinised side being arranged below. When the whole bar is immersed in water the optical images of the reference lines lie in the neutral plane of the bar, that of no flexure. The lines lend themselves to considerable precision, and are perhaps the finest ordinary lines that have yet been ruled.

The lecturer, however, has lately been experimenting with much finer lines, indeed lines of an altogether different order, ruled on quartz by Mr. H. J. Grayson, of Melbourne, of the fineness of 40,000 to the inch, the one forty-thousandth of an inch being the approximate wave-length of red light. Five such lines form the location-signal, the central line of the five being the reference line itself, proposed by the lecturer as the ultimate type of reference mark for standard metrology in wave-lengths of light, for which purpose even the finest of ordinary engraved lines are far too coarse, including many wave-lengths in their thickness. These lines on quartz are not so satisfactory, however, as the perfect ones ruled by Mr. Grayson on speculum metal, as quartz appears to splinter slightly along the edges of the lines. It would be very interesting to see what would be the effect of ruling such fine lines, one wave-length distance apart for red light, on polished slabs of fused silica, which might be expected to be less subject to splintering than crystallised silica is, possibly on account of its slight tendency to cleavage. It is to be hoped that this may shortly be put to the test of experiment. In any case fused silica is bound to prove of great value in the future of metrology.

In now bringing these lectures on rock crystal to a close, it may fairly be said that they have made it plain how exceedingly important and useful a material this mineral is, and that a whole course of lectures can by no means exhaust so fertile a subject. No mention has been made of the amorphous and semi-crystalline forms of natural silica, such as chalcedony and agate, or of the hydrated form of silica, opal, the varieties and combinations of which, and their impure but exceedingly beautiful forms, such as carnelian, onyx, jasper, sard, sardonyx, and chyrsoprase, so powerfully impress the mind with their exquisite colour, markings, and infinite variations. The prime object has been to indicate how perfectly quartz exemplifies the characters of a crystallised substance, and how instructive an example it affords of every property usually associated with a perfect crystal. Its uses in the arts and in industry have also been prominently brought forward in this last lecture of the series, and to the instruction derived with respect to the pure crystallography, optics, and other physical properties of quartz and of crystal structure in general, has thus been added abundant evidence of the rapidly-growing importance of this truly extraordinary mineral, in not only every variety of scientific work, but in regard to artistic adornment and the common purposes of everyday life.

THE MANUFACTURE OF PONT-L'EVÊQUE CHEESE.

Pont-l'Evêque cheese, one of the most favoured varieties known in France, is made in small squares four and a half inches wide and one inch thick. Its rich yellow colour is obtained by using a colouring matter, made from the pulp surrounding the seeds of the tropical plant *Bixa orellana*. It is one of the oldest brands of cheese known in France, having been made as long ago as the thirteenth century. It is estimated that £78,000 worth of Pont-l'Evêque cheese is manufactured annually, the principal centre of production being the district of Pont-l'Evêque in north-western France. The making of the cheese continues throughout the whole year, but the best results are always obtained in September and October. In the process of ripening, the mould, so important in the preparation of Brie and Camembert cheese, is not considered essential. Dependence is not placed on the germs in the air or surrounding substances, but upon the ferments, which are added to the milk by the rennet at the time of curdling. The curdling of the milk, an operation which forms the basis of all cheese-making, is obtained in the manufacture of Pont-l'Evêque by means of a commercial rennet. It is effected at a temperature of 89° to 94° F., depending on the outside temperature. The American Consul-General in Paris says that after the milk has been thoroughly strained, it is heated to the proper temperature for renneting. The rennet is then added, diluted in a quantity of water. Many cheese-makers add one-twentieth part of boiling water, so that the milk, which has an initial temperature of 89° or 90° F., is brought to nearly 94°. This is also the proper time for adding to the milk the required

amount of colouring matter. The coagulation completed, the breaking of the curd is begun. This is effected by cutting vertical slices in two opposite directions, forming angles of 45°. The division of the curd aids the separation of the whey from the curd. With a skimming ladle the curd is raised in thin horizontal slices, and placed upon mats of reed or rye straw. To prevent too rapid cooling, hot cloths are thrown over the curd. In about thirty minutes the separation of the curd from the whey should take place. Wooden boxes in the form of squares are used for moulding the cheese. These boxes are made of beech or ash, and the sides are pierced with holes. The curd is placed into the mould, little by little, with the fingers, care being taken to press it down firmly so that the lumps of curd will be free from surface fissures. After the mould is filled, it is turned over on a dry mat, this operation being repeated six or eight times within an hour. After about twenty-four hours the cheese is taken out of the moulds and the entire surface covered with a thin layer of fine salt, particularly the surface exposed to the air. Twelve hours later it is again turned and salted, special care being taken with the side exposed to the air. The next day marks the end of the salting process. Following the salting comes the drying, which takes place in the drying-room. In this room are placed open tables to receive the cheese, which is placed upon a layer of straw. The cheeses are turned over every day, and occasionally washed with additional colouring matter and light brine for a period of eight to twenty days according to the season. From the drying-room the cheeses are taken to the cellar. There they are placed on a plain surface, one against the other and covered with a cloth to prevent too great an evaporation. They are turned from time to time to ensure perfect uniformity in the ripening process, which is usually completed in about twenty days. The first quality cheese thus obtained is noted for delicacy of flavour and savouriness. Cheeses of the second class are always made during the spring and summer months, the milk used being that of the morning's milking added to that of the evening before. Before the curdling, there is added a quantity of boiling water equal to about one-fifth or one-eighth that of the milk. The third-class cheese is produced chiefly during the winter months. The milk of one, or even two days before is used, after having been skimmed. It is brought to the curdling point by the addition of boiling water. The principal markets for Pont-l'Evêque cheese are Pont-l'Evêque, Breuil-en-Auge, Beaumont, and Trouville, situated in the north-western part of France.

ARTS AND CRAFTS.

The London Schools.—The London Schools have now been at work for some weeks, and are apparently pursuing the even tenor of their ways, in spite of a certain amount of anxiety on the part of the teachers as to how the forthcoming changes in the examination arrangements may affect them later on. Most of the schools, probably, receive a larger grant from the London County Council than from the Board of Education, so that the trouble is not wholly financial, but there seems to be an idea that if the Board drops the elementary examinations it may have a bad effect on the numbers. That may be quite true, of course, but on the other hand, it is at least an open question whether the function of schools of art is to teach quite elementary students, and whether it would not be better to insist on some sort of elementary knowledge from students who wish to be admitted to them. Possibly, at the present moment most school of art teachers would answer that question by a rather emphatic "No"; not so much because they have any overwhelming desire to teach beginners as because they mistrust the quality of the training which students would be likely to receive before they came to them. That brings us to the much debated subject of the training of art teachers for ordinary secondary and primary schools, a subject which is well to the fore just now, thanks partly to the recent report on the Royal College of Art and the suggestions of the Council of the National Society of Art Masters. Something certainly urgently needs doing in this direction. The training department in connection with the Clapham High School is attempting something, it is true, and at least one of the training colleges for elementary school teachers is encouraging a few of its students to specialise in art. But this is not enough: there is undoubtedly a need for a system of training more definite and more far reaching, and carrying with it some kind of official recognition. Further, at this time of day any scheme which confined itself entirely to drawing, and did not make some provisions for training which would enable these teachers to give instruction, really efficient instruction as far as it went, in at least one simple craft, would be quite inadequate.

Many of the schools held, as usual, little exhibitions before the beginning of the session's work. These consisted sometimes of the work of actual students, sometimes of that of both present and past pupils. The disappointing thing about these little shows, from the point of view of the intelligent visitor, is that the best work has generally been on view before, either at the National Competition or at the London County Council exhibition. But, of course, the object of little collections of students' work of this kind is not so much to appeal to the outsider as to attract new pupils, and they certainly do enable intending students to see the kind of work that is being done at a school before they pledge themselves to attend it, though, perhaps, in some cases the work which really attracts is that of people who are by this time themselves teachers.

Furniture.—Though the spring is the best time for estimating what is going on as far as decoration proper is concerned, and for gauging the direction

in which pattern design is moving, there is generally a little spurt of activity in the early autumn. It is true that manufacturers of wallpapers and the like do not issue new patterns; those are reserved for the spring when, at the time of the yearly spring cleaning, householders are traditionally expected to renovate their domains. Still, amongst the numerous accessories which help towards decoration, there are always a goodly number of fresh things to be seen at this season of the year, when folk have returned from the country and are anxious to settle in comfortably for the winter before the cold weather is upon them. Amongst other things, there is a good opportunity of seeing how matters have been moving of late in the way of furniture design. To begin with, the idea, revived originally by some of the artist craftsmen, of making use of the grain of the wood to provide decoration for their furniture, has now evidently become thoroughly popularised, and is pretty often carried to excess. Some of the Australian woods, for instance, have very strong markings which, beautiful as their effect often is in small surfaces, want very careful handling on large pieces of furniture. When wood of this kind is used, say for large cupboards or bureaus, the effect is much more satisfactory when the panelling up is so schemed that, instead of continual patterned surfaces, we get plain unobtrusively marked wood, or at least broken effects, framing up the more definitely patterned portions. The eye wants some rest and, if it does not get it, speedily tires.

The simple, somewhat heavy furniture (mainly in oak) which came into vogue some years ago more or less as an accompaniment to the cry for the simple life, seems to have come to stay. It is now to be found practically everywhere as one of the types regularly supplied by commerce. Occasionally it has suffered from its popularity. We find it, for instance, most incongruously decorated with cheap and altogether unpleasant carving—evidently to suit the taste of customers who, whilst they have no love for simplicity, do not wish to be behind the times and are glad to clutch at the chance of what seems to them like a satisfactory compromise. Sometimes, on the other hand, the bedroom suites of this type err rather on the side of excessive rusticity, and we find washstands with tiled tops on which, apparently with the idea of producing a rough and countrified effect, the tiles instead, of being set as close together as possible, have a good ½ inch of jointing between them. As this is, of necessity, white, it looks very ugly with dark tiles, and is, of course, in any case extremely unpractical. But, whatever may be said against individual examples of this kind of simple furniture, it must be admitted that both it and some of the more elegant bedroom furniture are a very great improvement on the more pretentious and fussy suites which were the normal thing a few years ago—and which were quite hopelessly out of place in smallish suburban and country houses.

The rather pretty little simple marquetry patterns which were so pleasing a feature of some of the best made furniture a little while ago, seem to have fallen somewhat into disrepute. They are still being used, of course, perhaps rather more than they were, but not always with that discretion which helped to give them the success which originally they have undoubtedly had.

When we come to accessories, it is just worth noting how the introduction of glass jugs and hand basins has progressed. This is, perhaps, a natural reaction from the very dark, heavily glazed crockery constantly to be met with some time back. However that may be, glass ewers, etc., are very much to the front—some plain, more moulded, and a good many cut—whilst quite a number of them are enriched with gilding which looks very pretty when they are filled with water. In contrast, again, to some of the pottery shapes recently in vogue, these glass jugs are quite often very good in form.

Again, it is rather amusing to note how the prevailing fashion in ladies' dress has had its effect on the colour and design of cushion covers, which are now often to be seen in shades and patterns recalling not only the colour but the design of the fashionable guipures. Some of these patterns, by the way, are of a simple geometric type, which very few people would have looked at only a very short time ago.

EMPIRE NOTES.

The Destiny of Tonga.—It is rumoured that there is a movement afoot in the Colonial Office which may result in the Friendly Islands passing from the status of an independent kingdom, under British protection, to the position of an appanage of the Empire under the direct control of New Zealand. Should this prove to be well founded the rule of the South Sea chieftains will come to an end. No one who has followed diplomatic developments in the Western Pacific for the last decade can have any doubts as to the ultimate destiny of Tonga, but with the elimination of the protectorate the curtain will be rung down on one of the quaintest experiments in the art of government the world has seen. It seems a melancholy fate for a country, that aforetime rejoiced in the picturesque mimicry of European monarchism, to become a mere prosaic governmental department in the sphere of operations controlled by New Zealand. George Tubou I., a man of high character and ability, died actual king of the land. History links him up with the days of club law and spoils to the victor. The pomp and ceremonial of a court, feebly fashioned upon European models, was a poor business compared with the impressive strength of the king sitting in a "kara" ring, or conducting the affairs of state with the well-known club for sceptre. His grandson, Tubou II., the reigning chief, is a man of considerable power, though his kingship is of a different stamp from

that of his grandfather. It remains to be seen by what method of persuasion this independent race has been induced to become a part of the British Empire. When the Samoan group was divided between Germany and America, the Friendly Islands were recognised as being in the British sphere of influence, notwithstanding that there was a king, a parliament, a constitution, and all the paraphernalia of state. The real ruler of Tonga has been for many years past the High Commissioner, the Governor of Fiji. The process by which this petty kingdom becomes part of the Empire is analogous to the steps by which British rule has expanded in other parts of the globe.

The Maori Population of New Zealand.—It is interesting to observe that, while the Australian aboriginal is fast dying out, the Maori race in New Zealand is growing in strength and numbers. According to statistics taken from the census of last March, the total native population is computed at 49,350 — an increase in five years of 1,617—to which should be added 215 Maoris who live in the Chatham Islands. It is a difficult matter to procure accurate figures as to the number of half-castes. Probably most of these, as well as a large proportion of the Maoris themselves, are now living in European fashion. There has been a great difference in the observance of sanitary laws, and the natives are beginning to realise that the excessive mortality among their children has been caused to a large extent by insanitary conditions prevalent in their settlements. Generally speaking, the health of the natives has been exceptionally good, and in this respect they compare most favourably with other native races in countries occupied by Europeans. The public service is open to Maori youths, but the openings, for the most part, are limited. The Government, however, has always displayed a sympathetic regard for deserving Maori workers and those of fair education.

The Whaling Industry in South Africa.—The whaling industry is rapidly assuming large proportions in Natal and Cape Colony. At the present moment there are six or seven steam vessels employed in the trade at Durban, and it is no uncommon experience for these vessels to put to sea three times during a day, bringing back a whale each time. The profits of the industry are naturally large, and the regularity of captures of these monsters has given rise to a fear that before long the whale will be scared away from these shores, as was the case in New Zealand some years ago. There is no sign, however, of the supply of whales materially lessening. A large number of applications for shore sites have been addressed to the Government by syndicates, who desire to establish themselves at convenient positions along the south coast. It is stated that a company is being formed in Germany for the purpose of extending the industry to German East Africa. It is proposed to boil down the catch at a spot adjacent to Luderitzbucht. A company formed in British South Africa also has leased a portion of the foreshore in Sheerwater Bay, between Luderitzbucht and Dias Point. Here they are setting up a plant for the treatment of the whales harpooned in these seas.

Burma's Oil Industry.—In a recent report published on the administration of Burma, it is pointed out that there was a decrease in production in the smaller oil-fields of that country, due to exhaustion in 1909–10. Yenangyaung, it is true, had an enormous increase in production, but this was due rather to greater activity of working than to increased productiveness. New prospecting licences in the Magwe, Minbu, and Pakokku districts have been freely taken; the areas of all concessions held have been carefully scrutinised for new wells and new fields; and all companies are rapidly and largely increasing their storage capacity for crude oil on the fields. The completion of the Burma Oil Company's pipe line leaves the tank steamers of the Irrawaddy Flotilla Company, and of the River Transport Company, available for the transport of the products of other oil companies to the refineries in Rangoon. Several new refineries have been constructed in Syriam. The small Burmese refineries at Prome have been closed, with one exception, owing to the difficulties in obtaining crude oil.

Fruit-growing Experiments in British Columbia.—The Province of British Columbia has, for a long time, been exporting the finest fruits of the Dominion of Canada. This has been in a large measure due to the scientific and careful methods employed by the growers. Steps are now being taken by provincial horticulturists to extend their experimental operations, and to this end efforts are being made to establish one or more experimental fruit-growing stations in the Columbia-Kootenay Valley, one of which will be allotted to the Windermere district. Growers have been invited to offer small tracts to be used for the purpose. This magnificent valley, into which the Canadian Pacific Railway is building from both ends, contains the upper courses of both the Columbia and Kootenay Rivers, and has been settled for a number of years. It has long been thought that it should be possible to grow hardier fruits there than heretofore. The present demonstrated fruit area of Eastern British Columbia does not extend beyond the West Kootenay where, however, 150 varieties of apples alone are said to be grown. The various districts of the West Kootenay are already in possession of provincial demonstration orchards, the most notable being close to Nelson, which are operated as model orchards. It is estimated that the West Kootenay has 1,000,000 acres of fruit land not requiring irrigation, while the higher, dryer, and colder East Kootenay, including the Valley mentioned, has at least an equal area of land that is proved to be superior for general farming.

Electric Power in Ontario.—A representative gathering of prominent chemists and metallurgists attended the convention of the American Electro-Chemical Society held recently in Toronto. Toronto should, in time, become one of the greatest world centres for electro-chemical industries, and many of the American chemists express the opinion that Ontario has water-power facilities sufficient to render her the dominant manufacturing province of Canada. Dr. Buckland, of New York, and other authorities, have predicted considerable development in the mines of New Ontario by the aid of electrical power. On account of the absence of coal, and the difficulties of transport, there is nothing to prevent the demand for electrical power and its application to the reduction of ore on the mine itself, to which it may be easily and cheaply conveyed. Dr. J. W. Brown, of Cleveland, states that the electrical furnace was a practical proposition in these regions, where wood was plentiful and the necessary amount of carbon in the form of charcoal readily obtainable. Dr. Herring, of Philadelphia, stated that once cheap power could be obtained, the manufacturers would not hesitate to instal electricity even for baser metals. The drawback at present, he thought, was that distributors of current were too prone to charge the highest figure which the particular industry could bear, without any consideration as to the actual cost. Doubtless this method is a mistake, as the rapidity of electrical development depends very largely on cheapness. At the convention the practical working of the Ontario Government's hydro-electric system came in for special commendation. This system, as pointed out formerly in these columns, is a combination of Government control and private ownership. The Commission is able to buy power in bulk from private companies, and to act as distributor to towns and cities scattered over wide areas, on terms advantageous to the whole community.

American and Canadian Waterways.—The International Joint Commission appointed to deal with disputed questions between the United States and Canada is now complete, and a meeting of the American and Canadian Commissioners is about to be held at Washington. The Commission will take up, at its first meeting, the important question of the development and use of the waterways between the two nations. It will not concern itself, for the present, with the location of boundaries, but with the adoption of the waterways for industrial purposes, with the granting of permits for use, and with the conservation of the interests of the people on both sides of the border. Among the subjects to be considered will be plans for developing power in the St. John River, the development of the Richelieu River, and the outlet of Lake Champlain; for the development of water power in the St. Lawrence between New York State and the Province of Ontario; for a sanitary canal around Niagara Falls on the American side; for power development in the Rainy River, between Minnesota and Canada and in the Lake of the Woods; and for the use of waters in Montana and Saskatchewan for irrigation purposes. All these objects are excellent, and the accomplishment of them will tend to the advantage of both countries. By the appointment of this Commission it will be possible for the negotiations between the United States and Canada to be conducted direct instead of being made dependent upon diplomatic communications between Washington and London.

Canadian Coinage.—The new Canadian "cents." appear without the time-honoured "Dei Gratia," or any equivalent therefor, on the face of the coins, so that, so far as this coinage issue is concerned, the name of God is omitted. Read in the light of the fact that, years ago, Anglo-Saxon countries pointed scornfully at France for omitting the name of the Deity from their coinage, and of the recent decision of the Congress of America to retain the phrase "In God we trust," which Mr. Roosevelt had proposed to omit, the action of the Canadian authorities is likely to be adversely commented upon both in America and in the United Kingdom. Why the dies sent out to the Canadian Mint differ in this respect from those used in this country seems to require explanation. Although, for the moment, the alteration in the Canadian coinage does not appear to have attracted much attention in the Dominion, there is little doubt but that the matter will excite some comment among Canadians, many of whom will not care to be regarded as less reverential or religious, even in their coinage, than the old country, or than their neighbour, the United States.

CORRESPONDENCE.

DEW-PONDS.

With reference to Colonel Pitt's letter in last week's *Journal*, and his observation that the dry summer has afforded an opportunity of testing the tradition that "dew-ponds" derive their supply of water from dew or mist, it may be pointed out that there has been very little dew and very little mist during the summer, so that the basis of the test is lacking. Heavy dews and mists occur chiefly on clear, calm nights, when the air is damp; but unusual dryness of the air has been a marked feature of the summer, and there has often been a creep of air or a breeze during a considerable part of the night. There have, of course, been dews, but it was notable how often one was able to walk on grass late in the evening or at night without getting one's boots damp; and even after clear nights there have been mornings when the grass has been hardly damp, very far short of the drenched condition of grass so usual on English mornings in August and September, and even in June and July. Deposition on the surface of water warmed by the day's sunshine, if it does occur in

normal summers, would lag far behind the deposition on grass.

The matter of gain and loss of moisture has interested me in connection with water supplies in dry countries with bright sunshine; and during this summer I was struck by the great effect which the long duration of sunshine in these latitudes may have, in spite of its flatter angle at noon, compared with southern Europe or the tropics.

Even if there had been heavy dews and mists during the summer, the correctness of the dew-pond theory would not have been tested. It is a matter of balance, whether the pond gains or loses, and the hot sunshine, unusually effective in the early morning, and late evenings, owing to the lack of mist, might easily have turned the scale to loss, especially as there has been an unusual amount of dry easterly and north-easterly breeze.

I do not here consider the question whether the dew-pond theory is true or untrue, this letter being confined to two points: first, that there has been little dew or mist this summer; and, secondly, that even if there had been heavy dews and thick mists, the forces of evaporation during this summer might have been strong enough steadily to reduce the stores of water in the ponds.

REGINALD RYVES, F.R.Met.Soc.

October 21st, 1191.

ORIENTAL CARPETS.

The note about the Oriental carpet trade in last week's *Journal* prompts me to add what will, perhaps, be fresh information to some readers of the *Journal*.

The export of Oriental carpets from Smyrna and Constantinople has been falling off for some years as regards British ports, probably in consequence of the increased export direct to Germany.

The reason for this is that until a few years ago Germany obtained her Oriental carpets in London, but has since found it increasingly easy to import them direct.

The fiscal arrangements of the countries in question are directly responsible for our loss of this trade, which was, not many years ago, entirely in our hands. The fiscal policy of Great Britain with regard to this trade has been precisely what would have been devised to make the trade impossible, and the natural result has followed.

It is too late for us to do anything to recover our trade to Germany in Oriental carpets, and the time is perhaps coming when we shall be buying from Germany, so successfully are our rivals handling the goods.

A much more important side of this question, however, is the effect it will have upon our home industry of carpet weaving. The Oriental carpets now coming to this country take the place of goods that might be made here, and I estimate that were this trade secured there would be employment for 20,000 carpet weavers in addition to those at present employed in this country.

The manufacturers of carpets in this country have at present to face the competition of all the world without any assistance or protection from national policy. No other country is so situated, and, on the the other hand, Turkey, Austria, and Germany have advantages in lower labour rates, which put their products in our markets at far less than our cost. An import duty would put up prices, but in the case of a carpet of which the price is already high, would that seriously matter? A man buys a real Turkey carpet only once or twice in his lifetime, and an enhanced price would be no hardship to the consumer in the case of these goods.

C. A. HINDLEY.

October 24th, 1911.

OBITUARY.

THE EARL OF ONSLOW, G.C.M.G.—The Earl of Onslow died at Hampstead on the 23rd inst. at the age of fifty-eight. Educated at Eton and Exeter College, Oxford, he soon developed a faculty for administrative work and an interest in public affairs. In 1887 he served as Under-Secretary for the Colonies; in the following year he was appointed Parliamentary Secretary to the Board of Trade, and from 1888 to 1892 he acted as Governor and Commander-in-Chief of New Zealand. During this period was born his second son, the Hon. Huia Onslow, who received a Maori name in honour of his birthplace, Maoriland. Three years after his return from New Zealand Lord Onslow was appointed Under-Secretary of State for India, and in 1900 he returned to the Colonial Office for a further period of three years. In 1903 he became President of the Board of Agriculture, and it was here, perhaps, that his best work was done. Himself an owner of over 13,000 acres, he was keenly interested in all kinds of agricultural questions, and during his term of office at the Board he appointed important departmental committees to inquire into sheep-dipping, the Fertilizers and Feeding Stuffs Act, the fruit industry, and railway rates, all questions of vital importance to agriculturists.

In 1905 Lord Onslow was appointed Chairman of Committees in the House of Lords, a post which he only resigned last spring on the ground of ill-health. He was also a member of the House of Lords Select Committee which, with Lord Rosebery as chairman, sat to consider the reform of the Second Chamber.

Lord Onslow became a member of the Royal Society of Arts in 1903. He had previously taken the chair here on two occasions: in 1893, at a meeting of the Colonial Section when Mr. (now Sir) Westby B. Perceval read a paper on "Aspects of Imperial Federation, from a Colonial Point of View," and in 1899, when Mr. H. A. Acworth, C.I.E., read a paper on "Leprosy in India" before the Indian Section.

COLONEL THOMAS MYLES SANDYS, D.L.—Colonel T. Myles Sandys died on the 18th inst. at his London residence in Jermyn Street. Born in 1837, he was educated at Shrewsbury. He entered the service of the East India Company, and served through the Indian Mutiny in the 73rd Bengal Native Infantry. He afterwards exchanged to the 7th Royal Fusiliers, in which regiment he served for twenty years. He was subsequently lieutenant-colonel of the 3rd Battalion (Militia) of the Loyal North Lancashire Regiment, retiring as honorary colonel in 1897.

Colonel Sandys represented the Bootle division in Parliament from its creation in 1885, until his retirement in March last. He was deeply interested in all matters connected with the Army and Navy. He became a member of the Royal Society of Arts in 1879.

NOTES ON BOOKS.

COLLECTIVE INDEX OF THE "JOURNAL OF THE INSTITUTE OF BREWING": 1887-1910. Compiled by William H. Bird, A.C.I.S. London: Harrison & Sons. 10*s*. 6*d*.

Since 1895 the *Journal of the Institute of Brewing* has formed a complete record of scientific and practical work carried out in connection with brewing, malting, distilling, and the allied industries, in all parts of the world. The collective index, which is an exhaustive book of reference to the Journal, covers 550 pages. Divided into four parts — (1) Authors, (2) Subjects, (3) General Matter, and (4) List of Journals from which papers have been abstracted—it has been made, by this means and by a system of cross-indexing, almost impossible to miss any reference having a bearing upon the subject to be traced. Part (4) probably represents the most complete list of journals of interest to the fermentation industries extant.

STEVENS' MERCANTILE LAW. Fifth Edition. By Herbert Jacobs, B.A. London: Butterworth & Co. 10*s*. 6*d*.

The fourth edition of this well-known manual appeared eight years ago, and since that date it has been twice reprinted; but in the meantime the law has undergone several important changes owing to statutory enactments and decisions of the courts. The present edition has been revised by Mr. Jacobs (who was also responsible for the third and fourth editions), and brought thoroughly up to date. Thus the chapter on Marine Insurance has been rewritten in the light of the codifying Act of 1906, while another improvement is that the dates of all cases cited are now given.

The book is divided into five parts: (1) General View of the Law of Contracts; (2) Rules Relating to Parties to Contracts; (3) Rules Relating to Subject-matter of Contracts; (4) Bankruptcy; and (5) Arbitrations. There is also a useful appendix on patents, trade-marks, and copyright, and a very full table of the statutes cited in the volume.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, OCTOBER 30...Cold Storage and Ice Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Major A. E. M. Norton, "Some Suggestions for the Improved Marketing of Frozen Produce."

East India Association, Caxton Hall, Westminster, S.W., 4 p.m. Colonel Sir Thomas Hungerford Holdich, "The Gates of India."

Engineers, Junior Institution of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Mr. George Evetts, "Notes on Design and Construction in Gas Works."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Oscar Browning, "The Study of History."

Architectural Association, 18, Tufton-street. S.W., 7.30 p.m. Mr. H. H. Hill, "The A.A. Excursion to the Loire."

TUESDAY, OCTOBER 31...Sociological, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. Gilbert Slater, "The Universities and the Democracy."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. F. G. Newmarch, "A Glimpse of Spain."

WEDNESDAY, NOVEMBER 1...Public Analysts, at the Chemical Society's Rooms, Burlington House, W., 8 p.m. 1. Messrs. H. S. Shrewsbury and A. W. Knapp, "Notes on Shrewsbury and Knapp's Process for Estimating Cocoanut Oil." 2. Mr. H. S. Shrewsbury, "Note on a Counterfeit Gold Coin." 3. Mr. L. M. Nash, "Note on the Examination of Finnish Turpentine." 4. Mr. L. Reed, "Note on the Approximate Estimation of Starch by Iodine." 5. Mr. E. H. Miller, "Note on the Gravimetric Estimation of Phosphorus in Milk." 6. Dr. J. McCrae, "Kobert's Reagent as a Test for Salicylic Acid." 7. Mr. Wilson H. Low, "Precipitation of Nickel Compounds and Preparation of Spongy Nickel."

United Service Institution, Whitehall, S.W., 3 p.m. Colonel A. J. A. Wright, "The Probable Effects of Compulsory Training on Recruiting for the Regular Army."

Royal Archæological, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. A. Hamilton Thompson, "The Registers of John Gynwell, Bishop of Lincoln, for the year 1349."

THURSDAY, NOVEMBER 2...Child Study, 90, Buckingham Palace-road, S.W., 7.30 p.m. Mr. H. Holman, "Psychology and Grammar."

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. F. B. Power and T. Callan, "The Constituents of the Seeds of Casimiroa Edulis." 2. Messrs. P. von Romburgh and G. Barger, "Preparation of the Betaine of Tryptophan and its Identity with the Alkaloid Hypaphorine." 3. Messrs. G. Barger and W. W. Starling, "β-2-methoxy-naphthylpropionic Acid and Methoxy-peri-naphthindanone." 4. Messrs W. J. Pope and J. Read, "Dihydroxydihydrindylamine and its Resolution into Optically Active Components." 5. Messrs. A. Senier and R. Clarke, "Studies in Phototropy and Thermotropy. Part II.—Naphthylideneamines." 6. Mr. A. J. Ewins, "Some Derivatives of 4-(or 5)-methylglyoxaline." 7. Mr. J. W. Dodgson, "The Stability of the Double Oxalates of Sodium and Nickel, and Sodium and Cobalt." 8. Messrs. M. J. Burgess and R. V. Wheeler, "The Lower Limit of Inflammation of Mixtures of the Paraffin Hydrocarbons with Air."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. A. B. Keith, "The Development of the Constitution of the Commonwealth of Australia."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Dr. Tempest Anderson, "Matavanu, a New Volcano in Savaii."

Rontgen, 20, Hanover-square, W., 8.15 p.m.

Journal of the Royal Society of Arts.

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FRIDAY, NOVEMBER 3, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

ARRANGEMENTS FOR THE SESSION.

The Opening Meeting of the One Hundred and Fifty-Eighth Session will be held on Wednesday evening, November 15th, when an address will be delivered by LORD SANDERSON, G.C.B., K.C.M.G., I.S.O., Vice-President and Chairman of the Council. The chair will be taken at Eight o'clock.

The following arrangements have been made for meetings before Christmas:—

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

NOVEMBER 22. — JAMES DOUGLAS, LL.D., Past President Am.Inst. Mining Eng., "The Industrial Progress of the United States of America."

NOVEMBER 29. — A. E. BERRIMAN, "The Efficiency of the Aeroplane."

DECEMBER 6.—J. A. J. DE VILLIERS, "British Guiana and its Founder, Storm Van 's Gravesande." LORD REAY, G.C.S.I., G.C.I.E., LL.D., will preside.

DECEMBER 13.—W. YORATH LEWIS, M.Am. Soc.M.E., A.M.Inst.Mech.E., A.M.Inst.E.E., "Continuous Service in Passenger Transportation."

INDIAN SECTION.

Thursday afternoon, at 4.30 o'clock:—

DECEMBER 14.—J. TRAVERS JENKINS, Ph.D., D.Sc., Superintendent of the Lancashire and Western Sea Fisheries, "Fisheries of Bengal."

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

PROFESSOR VIVIAN B. LEWES, "The Carbonisation of Coal." Four Lectures.

Syllabus.

LECTURE I.—NOVEMBER 27.—*The Composition of Coal.*

LECTURE II. — DECEMBER 4. — *The Methods Employed in the Destructive Distillation of Coal.*

LECTURE III. — DECEMBER 11. — *The Thermal Conditions existing during the Carbonisation of Coal.*

LECTURE IV. — DECEMBER 18. — *The Possible Improvements in Carbonisation.*

Papers to be read after Christmas:—

CECIL THOMAS, "Gem Engraving."

F. MARTIN DUNCAN, "The Work of the Marine Biological Association."

H. A. ROBERTS, M.A., "The Relations of Science to Commerce and Industry."

JOHN NISBET, D.Oec., late Conservator of Forests, Burma, "The World's Decreasing Timber Supplies."

FRANK WARNER, "Silk."

CHARLES C. ALLOM, "The Development of Artistic Skill in the Applied Arts."

CYRIL DAVENPORT, "Illuminated MSS."

ERNEST KILBURN SCOTT, A.M.Inst.C.E., M.Inst.E.E., "The Manufacture of Nitrates from the Atmosphere."

CHARLES BRIGHT, M.Inst.E.E., "The Administration of the Imperial Telegraphs."

HAROLD COX, "The Interdependence of Morals and Economics."

PROFESSOR G. W. OSBORN HOWE, "Recent Progress in Radio-Telegraphy."

E. D. MOREL, "British Rule in Nigeria."

GORDON CRAIG, "Stage Illusion."

THEODORE E. SALVESEN, "The Whaling Industry of To-day."

LEONARD HILL, M.B., F.R.S., and MARTIN FLACK, M.A., M.B., B.Ch., "The Influence of Ozone in Ventilation."

E. A. GAIT, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

WALTER SAISE, D.Sc., M.Inst.C.E., F.G.S., "The Coal Industry and Collier Population of Bengal."

W. A. LEGG, M.Inst.C.E., "Irrigation in South Africa."

ALAN BURGOYNE, M.P., "Colonial Vine Culture."

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

January 18, February 8, March 14, April 25, May 16.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

January 30, February 27, March 26, May 7.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

VAUGHAN CORNISH, D.Sc., F.G.S., F.C.S., "Ocean-Waves, Sea-Beaches, and Sandbanks." Two Lectures.

January 22, 29.

LOUDON M. DOUGLAS, "The Meat Industry." Three Lectures.

February 5, 12, 19.

LUTHER HOOPER, "Hand-Loom Weaving." Three Lectures.

February 26, March 4, 11.

NOEL HEATON, F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

March 18, 25, April 1.

HOWARD LECTURES.

Monday evenings, at 8 o'clock:—

CAPTAIN H. R. SANKEY, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

JUVENILE LECTURES.

Wednesday afternoons, at 5 o'clock:—

CHARLES VERNON BOYS, F.R.S., "Soap Bubbles." Two Lectures.

January 3, 10.

THE ROYAL SOCIETY OF ARTS.*

By SIR HENRY TRUEMAN WOOD, M.A.,
Secretary of the Society.

V.—THE SOCIETY AND AGRICULTURE.
(1754–1830.)

When the Society of Arts first included agriculture among its objects, but little real advance had been made on mediæval methods. Yet new ideas were in the air, and as far back as the very beginning of the eighteenth century the commencement of the change can be discerned which was soon to abolish the old order of things, and to modify in the course of a comparatively short period the ancient system which had sufficed for so many generations. The time was favourable for improvement, and some central authority was badly needed to co-ordinate and direct the scattered efforts which were being made in England, Scotland, and Ireland to bring about an improved system of husbandry. As a matter of fact, side by side with the industrial revolution, an agricultural revolution was in progress, and the two great movements had their reciprocal influences upon each other. The development of the factory system was at once drawing the agricultural population into the towns, and was depriving them of their ancient means of livelihood by the destruction of domestic industry, while the growth of the urban population demanded more abundant food supplies, and thus necessitated improved systems of cultivation, by which alone those supplies could be provided. The old open-field system had by no means come to an end by the middle of the century, but the system of enclosure and the division of previously common land had made sufficient progress to render possible the existence of those large farms on which alone any attempt at scientific agriculture could be made. While the arable land of a village was divided up afresh every year among the commoners to whom it belonged, none of its temporary owners could do much, if anything, for its permanent improvement, and anything in the nature of rotation of crops was impossible when the strips of land changed proprietors at short intervals. Again, it was only on farms of considerable size that experiments in new methods of cultivation could be made, and there were many ready to try such experiments, for scientific agriculture had already made some advance. The system of a proper rotation of crops had been invented, and was being rapidly extended. New crops had been introduced, which alone made rotation possible. Of these the most important was the turnip, but clover and lucerne had also not long been added to the list. The new ideas promulgated by Jethro Tull, of the highest practical value, if based on erroneous theory, were attracting attention. Bakewell had just commenced his experiments in stock-breeding by the help of careful and judicious selection. Such were some of the main elements of the agrarian revolution in the successful development of which the Society of Arts was certainly one of the main factors.

In the original scheme of the Society agriculture was not included, and when the

* The previous articles of the series appeared in the *Journals* of June 9th and 16th, and September 22nd and 29th.

suggestion was made to Shipley that it should be so included, he met it with the not very conclusive objection that all the awards would be taken in those districts of the country in which the greatest progress had been made. Indeed, in the first list of premiums, that of 1756, there is no prize offered for any agricultural subject, unless, indeed, madder be considered as such. But this was soon altered. In the next list (1758) there are a number of prizes offered for agricultural improvements, and from that date onwards for the next fifty years agriculture occupied an important, indeed the most important, part in the lists of premiums.

In fact, the Society was for long mainly an agricultural society, and by far the most important one in the kingdom. There were some provincial societies in existence when it was founded, and others were soon formed, but it was in communication with all of them, and it was the centre to which information was sent, and from which it was distributed to the various parts of the kingdom.

In agriculture, as in the other divisions of its work, the fundamental idea which directed the Society's efforts was the offering of rewards, either pecuniary or honorary, for the successful carrying out of its objects. These rewards varied greatly in value, and they were carried on from year to year until the end sought for appeared to have been attained, and the new industry, or method of tillage, or crop, or whatever it might be, was so firmly established as not to require further assistance or protection. The scope of the prizes offered under the direction of the Committee on Agriculture was very wide. It included the successful rearing of all sorts of crops, even of such well-known crops as wheat, barley, oats and rye; the introduction of new forage plants and of roots for cattle-feeding; the suggestion of new methods of husbandry, their discussion and the supply of information about them; the invention of new implements or appliances and the improvement of old ones; information on the use and value of manures; suggestions on soil analysis; the treatment of cattle and sheep, and in fact any advance or improvement calculated to aid the progress of agricultural knowledge and practice. An annual list of suggested subjects was published, but the rewards were by no means confined to these lists, and the Society was quite as ready to consider and reward any useful proposal submitted to it from outside, as it was to award the prizes enumerated in its own catalogues.

The lists were prepared with great care, and modified from year to year, though we find the same offer repeated time after time, sometimes over a long period, even though large amounts had already been paid away among successful competitors, for it is to be remembered that the premiums were not, as a rule, in the nature of prizes to be taken once for all, but rather as grants-in-aid, to be repeated as long as there seemed to be any need for such assistance.

The value of the help thus rendered to agricultural progress is made evident by much contemporary testimony. In such a matter there is no higher authority than Arthur Young, and he, in his "Farmers' Letters,"* speaks in terms of high commendation of the Society's work, and comments on the premiums offered for 1766. Arthur Young was a member of the Society from 1769 till his death in 1820, and in 1774 he became Chairman of the Committee on Agriculture. He was therefore thoroughly well acquainted with the Society's work, and he was also a very outspoken person, and very candid in the expression of his opinions, so that any laudatory expressions from him are likely to be well justified. But, while on the whole he appreciated the Society's action, he thought that it might be improved upon, if, instead of merely offering prizes for successful agricultural experiments, they undertook the direction of such experiments themselves by selecting a number of intelligent farmers who could be trusted to carry out the work, and subsidised them, giving them also additional premiums in proportion to the manner in which the work was carried out.

There cannot be much doubt that a great deal of useful information might have been accumulated by following out Young's suggestions, though it might have been difficult to carry them into effect without more expense in the way of supervision than he contemplated. If they could have secured Young's services and got him to undertake the supervision of a scheme such as he suggested, the difficulties might have been overcome, but in the absence of a thoroughly competent expert to control the whole working of such experiments, it is difficult to see how they could have succeeded. In Mr. Wynn Baker the Dublin Society had such an expert, and they wisely placed considerable funds at his disposal, with very satisfactory results. It may, however, be observed that

* Letter VI., Vol. I. p. 214. The edition to which reference is made is the third, published in 1771. The first edition was published in 1768, the second in 1769.

during the many years while Young was Secretary to the Board of Agriculture after 1793, he never seems to have made any attempt to carry out the excellent suggestions he proffered for the benefit of the Society of Arts.

But while the distribution of rewards for successful experiment or invention was the principal device by which the Society endeavoured to attain its objects, it must not be thought that it was the only one. The diffusion of information by means of its publications was one almost equally important method, though its value was not recognised for some time. At first in the publications in which its proceedings were reported, to begin with in the *Museum Rusticum*, afterwards in Dossie's "Memoirs of Agriculture,"* and eventually in its regular *Transactions*, it recorded and disseminated a vast deal of agricultural information, and in this way aided most effectually the progress of agricultural science and practice. Another important agency was its "Repertory of Inventions," which, during the first half century of its existence, contained an excellent collection of models of agricultural implements. This was opened freely to the public, and by its means an opportunity of examining the latest implements and appliances was afforded to all who cared to profit by it. On occasion also the Society purchased machines and models in foreign countries, and obtained from abroad plants and seeds, which were distributed to the members.

When the Society began its agricultural operations one of the greatest difficulties which pressed upon the farmer was the need for a supply of winter fodder. He was then entirely dependent upon a meagre provision of hay, and that not of the best quality. The use of turnips for cattle food was only gradually making way, for although Arthur Young,† writing about 1769, speaks of "vast fields" of turnips in Norfolk, it is probable that the epithet was only used in comparison with the scanty crops grown in other counties, and, indeed, the remark was made by way of drawing attention to the small amount of the root which was actually being cultivated. The use of oil-cake for cattle food was hardly thought of. The editor of the *Museum Rusticum*,‡ in a note on a correspondent's article on feeding cattle, says that in Flanders the refuse from oil-mills had been given to cattle of all kinds, and, in another similar note, in the same volume,* he adds that oil-cake, from which the oil has been expressed, had been tried with success in England as well as in Flanders. It had not really come into use, however, for in the first volume of the Society's *Transactions* (1783), in connection with the offer of a prize for oil from cotton-seed, it was suggested that the seed, after the extraction of the oil, might form a useful food for cattle.

One of the first things taken up by the Society was the production of grass seed, and Arthur Young thought this a matter of the highest importance. Previously the only grass seed used was the sweepings of the hay-lofts, in which all sorts of seeds were mixed together, with a large proportion of seeds of undesirable weeds. The Society offered in 1762 several prizes for clean grass seed, giving instructions as to the way in which grass should be specially cultivated for seed, and promising also to find a market in London for any parcels of seed of a suitable character. Other prizes were offered for hand-picked grass seed, provided the seed was all of the same species.

Awards were also offered and awarded for the growth of crops considered to be suitable for winter or early spring food, including burnet, borecole, sainfoin, lucerne, winter clover, buckwheat, cabbages, beans, vetches, etc. These crops were then little known and sparsely cultivated.

The ordinary field turnip had been known for less than a century; it had been introduced some time—it is not really known by whom—near the end of the seventeenth century. Arthur Young gives the credit of its introduction to Jethro Tull (1674–1741), the father of scientific agriculture in England, but in this he was certainly mistaken. Both sheep and cattle were folded upon turnips, which were used to a very limited extent for winter food. Carrots and also parsnips were grown for cattle food, but their growth had hardly got beyond the experimental stage. Potatoes were only to be found in gardens, and were not used for cattle† until some time in the early part of

* "Museum Rusticum et Commerciale" (six vols. 8vo, 1764-66), "Memoirs of Agriculture and other Œconomical Arts," by Robert Dossie (three vols. 8vo, 1768-82).

† "Tour through the Southern Counties" (Second Edition, 1769), p. 25.

‡ Vol. IV. (1765) p. 378.

* *Museum Rusticum*, Vol. IV. (1765) p. 398.

† Although the potato was introduced into Ireland by John Hawkins in 1565, and into England by Sir Francis Drake in 1585, it had attracted so little attention, that in 1663 the Royal Society urged such of its Fellows as possessed land to plant potatoes, and to persuade their friends to do the same, in order to alleviate the distress that would accompany a scarcity of food. Nothing, however, seems to have come of this recommendation, and so little was thought of the potato for some years after that Bradley ("Historia Plantarum Succulentarum," 1716-1727) speaks of it as of little note, and in the "Complete Gardener" of London and Wise (1719) it is not mentioned at all.

the century. In 1779 Arthur Young received a gold medal for an account of the "Clustered Potatoe." This was one of the two medals* he had from the Society. For the cultivation of all these roots and for information as to the best methods of cultivating them, the Society offered many rewards, extending over a long series of years. The list also, at a later date (1805), included beet, on account of its use for cattle food, not for its sugar-producing qualities, which were a much later discovery.

All agricultural authorities are agreed as to the great part played by the introduction of the turnip into British agriculture. Without it any proper rotation of crops would have been impossible, and, until it was available for the purpose of feeding stock through the winter, farmers and graziers were in bad seasons forced to kill their stock cattle and salt the meat down for winter use. Hence for centuries the only meat generally available in the winter was salt meat. The extended cultivation of the turnip rendered possible the supply of butchers' meat in winter time to the rapidly increasing population, and so this modest vegetable was not only a prime factor in the agrarian revolution, but a valuable if overlooked agent in the progress of industrial development, and, indeed, of civilisation.

In encouraging the cultivation of the turnip the Society did its full share. Many pages in many volumes of the *Transactions* are devoted to the discussion of the best methods of growing it, and to dissertations upon the comparative advantages of drill and broadcast husbandry.

But besides encouraging the growth of crops already known, if not extensively cultivated, the Society was directly the means of introducing into England two roots which are now as important as the turnip itself—the swede and the mangel-wurzel.

Among the forage plants which had been introduced into England about this time was the turnip-cabbage (*Brassica oleracea caulorapa*), or chou-rave, now known under its German name of Kohl-rabi. This plant, according to Young, was brought into England from Carniola in 1749 by the Rev. Mr. Haste, Canon of Windsor, well known at the time as the author of "Essays on Husbandry." It had attracted a good deal of attention, and was to some extent being cultivated. It was the subject of two long articles in the *Museum Rusticum* in 1766,† which gives two good illustrations of the plant. It appeared to the Society that this little-known plant was well worth further attention, and amongst the premiums for 1867 was one for its cultivation. The offer attracted the notice of John Reynolds, a farmer of Kent, and he, being unable to obtain a supply of the seed in England, sent to Holland for some. The plants grown from this seed proved to be quite different from what he expected, and turned out to have large roots resembling that of the turnip, instead of the succulent stem of the Kohl-rabi. As a matter of fact he had been supplied with seeds of the Swedish turnip (*Brassica campestris rutabaga*); and this was the first introduction of the now well-known swede, then cultivated to some extent in Sweden, Russia, and Northern Germany, but absolutely unknown in England. This unknown plant he christened "the turnip-rooted cabbage," a not very suitable title, for though both it and the field turnip (*Brassica rapa*) are members of the cabbage family (*Brassicaceæ*) the swede is not a bit more like a cabbage than is the ordinary turnip. He grew a small crop of it and sent specimens to the Society. The value of the introduction was at once recognised, and a grant was made to Reynolds of £50. Seed from his plants was also distributed among the members for trial, and the new crop was recommended for its hardy nature and its capacity for standing frost. A full account of his experiments is given by Dossie,* and this is supplemented by some further observations on the nature and character of the plant, apparently written by Dossie himself. The full information on the subject first published by the Society attracted a good deal of attention, and for many years the Society continued to offer and present rewards for persons growing the "turnip-rooted cabbage," and for those who supplied information as to the best methods of securing large crops of it. The similarity of the two names evidently caused confusion, for appended to the offer of one of the prizes in 1769 is a note: "The plant here called the Turnep-rooted cabbage is not the same with the Turnep Cabbage, but that kind newly introduced into this country." For a long time it is only mentioned under this name in the Premium lists and *Transactions* (though it is said also to have been known as "Reynolds's Turnip"), but eventually the title seems to have been dropped, and the now well-known name of swede,† applied to

* He also received two small prizes in 1765 and 1767 for growing madder.

† Vol. VI. pp. 46, 220.

* Vol. I. p. 419.

† In "Les Plantes Potagères" (Vilmorin - Andrieux et Cie, Paris, 1883, p. 141) the authors, under the heading of "Choux-Navets," give as synonyms: Chou-rave en terre,

the plant from the country of its origin, came into use.

The introduction of the mangel-wurzel came a little later. In 1786 some seeds of the *Racine de disette*, or "root of scarcity," were given by Sir Richard Jebb—a very well-known physician at the time, who died in the following year—to the Secretary of the Society, Dr. More, by whom they were distributed to some of the members. This "root of scarcity"—soon better known by its German name "mangold-wurzel"* —according to a statement made by Jebb's executor, Granville Sharpe, had been discovered by a French cultivator in search of a new forage plant. It was suggested that both the leaves and the roots might serve as a table vegetable.

Amongst the members who received samples of the seed was J. C. Lettsom. He grew the seeds, and tried the leaves cooked like a cabbage and also the root, but does not seem to have greatly appreciated their flavour, though he thought that, as its name implied, the vegetable might be useful in times of scarcity. He was much interested in the new plant, which he considered much more suitable as a food for cattle than for human beings, and translated a treatise on it by the Abbé Commerell, which was published in London in 1787 under the name of "An Account of Mangel-wurzel." The particulars here stated are taken from the preface to that book. The value of the plant does not seem to have been recognised at first, and it was some time before it received the attention it deserved. No special reference to it appears in the Society's lists until 1814, when a gold medal was awarded to Leonard Phillips, "Portsmouth Road, beyond Vauxhall Turnpike," for "the growth of mangel-wurzel."

The implements then available for the farmer's use were very few and of a very inferior sort. For tillage there was the plough, varying in character in different districts of England, and the harrow. The horse-hoe* had not long been introduced, and the drill was known but rarely used. The crops were all got in by hand, the scythe, the sickle and the reaping-hook being the only known implements, as for centuries before. When the corn was harvested the only means for separating the grain from the straw was by the use of the flail.

This state of things, however, was very soon to be altered. In all industrial processes the substitution of mechanical power for hand labour was making rapid progress, and the change was beginning to be felt in agriculture as well as in manufactures. As the writer of the article on agriculture in the "Encyclopædia Britannica" puts it: "The quarter of a century immediately following 1760 is memorable in our agricultural annals for the introduction of various important improvements." And the introduction of these improvements was mainly due to the efforts of the Society of Arts. As evidence of this, another similar authority may be quoted, for in "Rees' Cyclopædia" (edition of 1819) the writer of the corresponding article, referring to the work of the Society, tells us that "a vast variety of different machines for facilitating the practice of agriculture have been invented and presented to the public, in consequence of the large premiums and bounties which have been offered" by it.

To trace in detail the history of all the improvements in agricultural implements and machinery which were due, in whole or in part, to the rewards paid by the Society, to the suggestions it put forward, or to the information it collected, would be a long and difficult task, and the result would not be either interesting or valuable, but it may safely be asserted that of all the implements new and old used by the farmer during the fifty or sixty years from 1760 onwards (not including, of course, ordinary hand tools) there was not one which was not either introduced or improved in consequence of the Society's exertions and influence.

Even the ordinary plough underwent a larger amount of development during this period than in the century or more preceding, not so much in consequence of any direct offer of premiums for improvements, as because the Society was always ready to take up and reward any

chou turnep. Noms étrangers:—*Anglais:* Turnip-rooted cabbage, swede, Swedish turnip; *Allemand:* Kohlrabe, etc.

"The Vegetable Garden"—a translation (1905) by W. Robinson of the above—(p. 166), under the heading, "Turnip-rooted cabbage (Swedish turnip); French, chou-navet; German, Kohlrabi," etc., says: "The varieties of turnip-rooted cabbages differ from the Kohlrabi (chou-rave) in that, instead of having the stem swollen over-ground, they produce, partially buried in the soil, a thick root which is about as long as it is broad, resembling a huge turnip, and of which the flesh is yellow in the Swedish turnips and white in the other kinds. The characters of the leaves and flowers of these plants indicate plainly that they are true cabbages. . . . The Swedish or turnip-rooted cabbage is an excellent vegetable."

In Vol. XV. of the *Transactions* (1797) it is mentioned that Lord Romney had presented the Society with "a quantity of Swedish Turnep-Seed."

* Mangel-wurzel is a beet, its botanical name being *Beta hybrida*. On its introduction it was known as *Beta vulgaris macrorhiza*.

* The date of the introduction of the horse-hoe into this country does not seem to be known. It was probably first employed in the vineyards of Italy and France, and that long before it was known here.

ingenious advance in this or any other implement. Such changes as were effected were mainly in detail. The frame was made lighter and better balanced; iron was substituted for wood in many parts of the frame, etc.; the shape of the share, coulter, mould-board, and other details were improved; the draught was lessened, and—a very important matter—the price was lowered, so that, as a general result, many of the ploughs commended and rewarded by the Society became popular, and are said to have sold well. All these improvements, however, were the result of rule-of-thumb experiment, and it was not until 1839, when the question was taken up by the Royal Agricultural Society, that any scientific investigation was really made into the principles which should govern the construction of ploughs. In that year, Mr. Philip Pusey published, in the first volume of the R.A.S. Journal (p. 219), the results of an experimental inquiry on draught in ploughing made by him, and the dynamometrical tests which he conducted upon the different sorts of ploughs had an immediate effect in improving plough construction.

The Society also, besides improving the character of the ordinary plough, did much to introduce ploughs of special types, applicable for trenching, draining and subsoiling, paring and scarifying, etc.

The drill had been invented by the enthusiastic and eccentric Jethro Tull in 1707, and its use advocated in his remarkable book, "Horse-hoeing Husbandry," in 1731, but it had not really come into use except to a very limited extent. Dossie * is responsible for the statement that Tull "only started the notion. The practice was very little pursued till the Society awakened the public attention to it by their premiums." That this statement was correct seems indisputable. The offer of a gold medal in 1762 for the best set of experiments and observations on the comparative merits of drill and broadcast husbandry produced a series of communications from Sir Digby Legard, extending from 1763 to 1768, and giving the result of a very careful series of tests carried on during those and previous years in Yorkshire, and also one from the Rev. Mr. Lowther, giving an account of similar experiments in Cumberland in or before 1763. Both these gentlemen received a gold medal, and their papers were the first of a long series of communications on the subject, which eventually established the value of the then novel system.

* Vol. I. p. 73.

Tull himself, in the various editions of his well-known book,* describes his drill in full detail and with abundant illustration. It must have been an excellent piece of apparatus, well suited for its work, and in its mechanical details considerably in advance of most contemporary machinery. Very probably its actual construction may have been deficient, and it was less effective in operation than appears on paper, for in those days the means of accurate machine construction were sadly lacking. But by all accounts, it was a good practical implement, and quite effective in operation.

Sir Digby Legard speaks favourably of the original machine, though he suggests certain additions and seems to have made some. Still it was not considered satisfactory, and prizes were, therefore, offered in 1761 for "drill ploughs which should cut several furrows, deposit the seed, and cover the seed with earth at one operation." The earliest award under this head was to the Rev. H. Gainsborough, a brother of the great painter, in 1766. He received £30 for a "drill plough." Other prizes followed in 1770, 1771, 1775, and for many years later.† The earliest patents for drills are those granted to Proud (in 1781) and to Cooke (in 1783). After this date the patents are numerous; there were about ten others in the next eight years.

Cooke's patent drill was submitted to the Society in 1787, and was commended, not—as the subject of a patent—being eligible for reward. Two reports, speaking well of the apparatus, were printed in the *Transactions*.‡

Still, though the advantages of the drill were recognised, and the machine itself became well-known, it was very many years before its use became general. As late as 1839, Mr. Pusey, in his inaugural address to the then newly-founded Royal Agricultural Society, addressing an assembly of farmers, thought it necessary to describe the drill as a machine "by which the seed is laid in regular rows," and mentioned that "it was not very much used, although it had lately become frequent."

* The book was first issued in an incomplete form in 1731. The first complete edition appeared in 1733. A further edition, with additions, was published in 1739. After Tull's death in 1740, other editions were issued, 1751, etc. Cobbett published an edition, with much of the original omitted, in 1822. An interesting account of Tull and his work, by the late Earl Cathcart, appears in the *Journal of the Royal Agricultural Society*, 1891, Third Series, Vol. II. p. 1.

† The best, among the early inventions, seem to have been those of Gale and Craik, both Scotchmen, to whom gold medals were awarded in 1771.

‡ Vol. V. p. 71, *et seq.* A description, with a drawing, will be found in the patent specification.

Another implement, which, though not invented by Jethro Tull, was the subject of his earnest advocacy, was the horse-hoe. A clumsy-looking implement is figured and described in the *Museum Rusticum*,* and various prizes for horse-hoes were awarded at different times by the Society. The earliest of these was a gold medal to the Rev. Mr. Hewett, in 1771. A number of awards were also made for harrows and for rollers, including a "spiky roller" in 1766.† In 1801 a silver medal was awarded to W. Lester for an implement "named by him a cultivator." The implement, as described and figured in the *Transactions*, is typical of the older form of cultivator before its modern improvements and alterations. It has vertical tines, slightly curved at the points. As is well known, the modern cultivator has various forms, is applied to many purposes, and is known by several names. It had, as originally designed, vertical coulters or tines, and was used for breaking up unreclaimed or fallow land. Probably the first description of it is that contained in Lester's communication to the *Transactions*.‡

In its efforts to encourage the invention of a reaping machine, the Society was certainly much less successful, and this chapter of the Society's history is decidedly less satisfactory to its historian than those which deal with the other agricultural implements.

In the premium list for 1774 appears the first offer of a reward for a machine capable of reaping corn, and this offer was continued with certain variations up to 1820, a period of forty-six years. During all this long period not a single award appears to have been made, and this is really inexplicable, because a number of inventions were brought out during this period, and several were at different times submitted to the Society. Most of these were impracticable and useless, but there was certainly one which was beyond much question the origin of the modern reaper. In the year 1812 Earl Percy sent to the Society a model of a machine made by John Common of Denwick, Northumberland, together with a certificate from John Thew and Thomas Appleby that the machine had successfully cut a patch of ripe oats. The apparatus is described, not very fully, in the committee minutes of April 15th; but the description is sufficient to show that the principal feature of the machine was a set of angular knives mounted on a horizontal bar, to which reciprocating motion was given by a crank, the corn being guided to the cutters by means of spikes or "fingers." This is precisely the mechanism of all existing reapers. Previous inventions, and some of a later date, used reciprocating blades or revolving scythes, but none of these gave the shearing or drawing cut which alone answers for cutting corn. The verdict of the committee was that the invention was incomplete, and they did not recommend it for an award—a verdict which simply shows that the committee as then constituted was unfortunately incapable of appreciating a very great and important invention, the very novelty of which was probably too great for them to realise its value.

The history of the invention is given in full detail in an article and some letters contained in the *Journal* of the Society for 1878.* From these it appears that Common co-operated with Ogle, who was the inventor of an unsuccessful reaping machine of the rotating scythe class, and that he employed one Brown to make certain castings for him, the patterns for which Brown in 1830 took to America. There he either constructed a machine, and disposed of it to McCormick, or gave the patterns to McCormick, and provided him with information from which McCormick was able to construct a machine. At all events there seems no doubt whatever that Common's reaper was the original of the machine brought out by McCormick, and exhibited by him in the American section of the 1851 Exhibition as his own. In consequence McCormick had for long the credit of being the inventor of the modern harvester until the true facts were brought out, and the invention attributed to its real author, John Common. At the same time it should not be forgotten that while the evidence seems to disprove McCormick's claim to be an original inventor, it does not in any way diminish the value of his public services in the introduction of the reaping machine. It often needs two men for the success of an invention, one to invent and one to publish. Generally the second man gets the profit, and it is not always certain that he may not deserve it; he does not generally get the

* Vol. VI. (1766) p. 402.

† *Museum Rusticum*, Vol. VI. p. 371.

‡ Vol. XIX. p. 142. This, however, is not the first use of the term, for in the list of implements in the Society's Repertory in 1783, a "cultivator" is mentioned. Murray's Dictionary gives a still earlier use in a translation of Duhamel's Husbandry, 1762.

* Vol. XXVI. pp. 369, 419, and 479. The information contained in these pages, with some further additions, was republished in a little book in 1907 by R. F. J. Common, the grandson of the inventor.

credit, though there seems no reason why he should not fairly claim a share of it. John Common's first machine appears to have been made about the year 1803, and to have grown out of a suggestion made by Ogle. Two other machines were made by him—one about 1811, and the third in 1812.

It makes it the more remarkable that Common's reaping machine was never rewarded by the Society that later, in 1818, he received a gold medal for a turnip drill, and later still, in 1844, a silver medal for a plan of putting new roots to old trees, neither of them comparable with his really great invention of the reaping machine. John Common was living in 1860, and a letter of his of that date is published in one of the *Journals* above quoted. John Thew, one of the witnesses of the trial above mentioned, was living in 1878, and was able at that date to confirm his former statements.

Nor was the Society more successful with another inventor of an original reaper, the Rev. Patrick Bell, whose machine was submitted to the Society in 1830, but was not rewarded on the ground that the description of the machine, which was an excellent one, had brought it sufficiently before the public, and that it did not therefore require the Society's aid to bring it into notice. Bell, who was then a young man studying for the ministry at the University of St. Andrews, invented his reaper in 1827, and it was tried the following year on a farm in Perthshire belonging to his brother, George Bell. He appears only to have constructed one machine, which worked regularly from about 1828 to 1868, when it was purchased for the Museum of the Patent Office. It is now in the Mechanical Engineering collection of the Victoria and Albert Museum.* A full account of his invention was given by Dr. Bell at the meeting of the British Association at Dundee in 1867, but unfortunately only a brief report of the paper appears in the Proceedings of the Association. Bell's machine was never patented, but later on, after attention had been drawn to McCormick's machine in the 1851 Exhibition, many machines were made after his model, and came into extensive use.†

Unlike most of the new agricultural implements, the reaping machine, when once attention had been drawn to it, came rapidly into use. Morton, in his "Cyclopædia of Agriculture," writing in 1851, in his article on "Harvesting Machines," refers briefly to Bell and McCormick, and says: "Notwithstanding all the ingenuity, however, that has hitherto been applied to the subject, reaping has been, and no doubt for many years, as we have said, will continue to be, a manual operation." In the same volume, in a later article on "Reaping Machines," which must have been written in or before 1855, he recants his views of four years before and describes at considerable length, with illustrations, an improved form of Bell's machine, and also those made by Hussey and by McCormick.

The earliest reference to a threshing machine must certainly be contained in the grant of Letters Patent in 1636 to Sir John Christopher Berg, for an "invencion to bee agitated by winde, water or horses for the cleane threshing of corne," but about this no further information exists, and the first machine which is known to have been used for the purpose of threshing corn was that patented by Michael Menzies in 1734. No specification was filed, and the only information afforded by the terms of the grant is that the machine "threshes with common swipples."* A description, however, is given by Maxwell in the *Transactions* of the old Scottish Society of Improvers in the Knowledge of Agriculture, which he published in 1743. This machine appears to have consisted of a number of flails, probably mounted on a central shaft or drum, which was either operated by hand or "by means of a great water-wheel and triddles." Though Maxwell recommends it, it does not appear that Menzies' machine was ever much used, and the first practical threshing machine was that of Andrew Meikle, patented in 1788, and stated to have been working in 1798 in Clackmannanshire. From the description in the patent specification it is evident that this machine may be regarded as the precursor of the modern threshing machines, since the principle on which it was constructed is really that which has been elaborated in the modern machine—a revolving drum with what he called "scutchers" working under a curved shield This apparatus soon came into practical use, and it was later largely improved upon, until it

* The excellent catalogue of this collection contains (p. 227, edition 1908) a brief historical note on harvesting machines and (p. 232, Nos. 1515 and 1516) a description of Bell's machine (No. 1515 is the original somewhat altered, and No. 1516 is a model of the original). There are also models and descriptions (pp. 232 and 233, Nos. 1,517, 1,518, and 1,519) of McCormick's reaper. No reference is made to Common, and it is to be hoped that the omission may be rectified in any future reprints.

† Much information about the earliest attempts to make reaping machines will be found in the "Appendix to the Specifications of English Patents for Reaping Machines," by B. Woodcroft, published by the Patent Office. This work is now seldom to be met with.

* Swipple is a north-country name for a flail, or the head of a flail.

developed into the apparatus now in common use.

The first award made by the Society for a threshing machine was in 1761, when £15 was given to John Lloyd. No description of this appears to be extant. A machine "for threshing and winnowing corn," for which fifty guineas was awarded in 1769 to John Evers, is highly commended by Dossie,* but it appears to have been rather a clumsy apparatus, and must have absorbed a great deal of power. The corn was spread on a revolving floor, and thus brought under the action of "a row of a kind of flails." This anticipated Meikle's by some twenty years, but was certainly inferior and worked on a very different principle.

Four years before this, in 1765, a bounty of £15 had been awarded to a Mr. Harvey for a threshing machine "used in Connecticut." From the note upon it in the manuscript minutes of the Committee on Agriculture, it consisted of a cone with longitudinal ribs revolving from a fixed centre over a floor on which the corn was laid. Nothing more is known of the apparatus.

After this the subject was neglected till 1801, when a gold medal was offered for a threshing machine which should be an improvement on any then used. This was awarded in 1810 to H. P. Lee. His machine consisted of four vanes or beaters on a central shaft working in a concave. Motion was given by a horse-gear through spur gearing to the shaft. A special merit of the apparatus seems to have been the high speed at which it could be driven.

The earliest suggestion of the use of apparatus for cutting or chopping straw for fodder is probably contained in the first volume of the *Museum Rusticum* (1761), p. 258, and further details are given in the volumes for 1765 and 1766.† In the first of these a "cutting-box" for fodder is described as a novelty, and in the second a fuller account is given with illustrations. It is simply the old form of chaff-cutter, common enough fifty years ago, in which the straw or straw and hay is pushed along a trough by hand, and cut by a hinged blade working across the end of the trough, the straw, etc., being held down, while the cut is being made, by a presser worked by the foot or otherwise. The machine is spoken of as something quite new and useful, and from the description it appears that the idea of using chopped straw for the food of cattle and horses was previously unknown.

* Vol. I. p. 86.

† Vol. V. p. 208, and Vol. VI. p. 8.

In 1769, 1770 and 1774, rewards were given for three machines for cutting straw, but no description of any of them has been discovered. It is very possible that one or other of these was the apparatus of the *Museum Rusticum.* In 1786 a reward of twenty guineas was given to James Pike, a watchmaker of Newton Abbot, for a chaff-cutter, which, though, from the illustrations in the *Transactions* * rather a clumsy apparatus, is probably the original form of the modern chaff-cutter, and is certainly a great improvement on the old form, with its hinged knife-blade worked by hand, and a hand-feed. In it a wheel or disc, carrying a single curved radial blade, revolves across the end of a trough, along which the fodder is fed by rollers operated by a worm and spur-wheels from the axle of the wheel. This is merely an elementary form of the present chaff-cutter, which is improved in details and in construction, but is precisely the same in principle. Eight years later, James Cooke patented the same idea, but fitted three knives on his fly-wheel, a great but obvious improvement. He also added a fixed blade, against which the revolving blades acted. Later inventors made the feed intermittent by means of a worm of varying pitch, or by driving the gearing through a wheel with only one tooth on each side, and improved the construction generally, but the chaff-cutter now universally known is only an improved version of those of Pike and Cooke.

The offer of a prize in 1766 for a machine for slicing turnips was condemned by Arthur Young† as rather trivial, but the apparatus sent in in answer to the offer was the first of a long series of inventions upon which a vast amount of ingenuity has been spent. The turnip-cutter of the present day is the result of the best part of a century's work, and it is not very long since the apparatus has been brought to perfection so that it will not only slice the roots but will cut them into "fingers" of a convenient size and shape for the food of cattle. In the following year, 1767, two rewards were given, £20 to James Edgell, and ten guineas to William Bailey. Dossie, who speaks well of James Edgell's machine, does not describe its action, but it evidently sliced the roots only, without any further division. In succeeding years other machines were commended or rewarded by the Society, but to judge by the records of the Patent Office it was very long before attention was really directed to this class of apparatus. The

* Vol. V. p. 62.

† "Farmer's Letters," Vol. I. (Second Edition, 1771) p. 234.

earliest patent for a turnip-cutter was granted in 1803, and it was not till 1834 that Gardner's machine, which afterwards came largely into use, was invented. After this there were numerous improvements.

The use of manures was hardly known, and, indeed, could hardly be known, so long as the open-field system endured. The practice of applying marl had been lately introduced in Norfolk, and a writer in the *Museum Rusticum* (Vol. II. p. 132) states that the Suffolk farmers were in the habit of using "cragg" containing "remains of marine shells." Farmyard manure was, of course, available, and the manuring of fields by folding sheep and cattle upon them was also practised. Lime was used to a very limited extent, and so were ashes. On the sea-coast, seaweed seems to have been utilised. Town nightsoil was employed in some localities where it was available, and the system of paring the surface and burning it was also found serviceable. Young, writing about 1769, mentions that oil-cake was imported from Holland for use as a manure at a cost of 15*s*. an acre. Its value as a cattle food was not generally known, though, as previously mentioned, such application has been proposed, and indeed tried.

In 1758 a prize was offered for a dissertation on "The Nature and Operation of Manures," the following being specified: "soot, coal-ashes, wood-ashes, lime, and nightsoil." The offer was continued in the same terms for very many years, "bones" being added to the list in 1817, and "salt" in 1825. After this date the prize was discontinued. During its continuance a good many awards were made, and various papers, none, perhaps, of very great value, were published in the *Transactions*.

The same list (that of 1758), which contains the first reference to manures, includes also a premium for a dissertation on "Soils and their natures." This was afterwards developed into an offer of a gold medal for "ascertaining the component parts of arable land," by a series of experiments. Detailed instructions were laid down as to the nature of the analysis of the soil, and practical proof was demanded of the improvement of sterile soil, by the addition of such "components" as appeared to be lacking, and the absence of which might be assumed to be the cause of the sterility. A good deal of information was supplied to the Society from time to time, and published in the *Transactions*, but it does not appear that the exhaustive series of experiments laid down by the Society were ever carried out in their entirety. The proposal, however, is not without interest, as marking the commencement of agricultural chemistry, which may be said to have first taken definite form in England when Sir Humphry Davy, after delivering a course of lectures in 1803 on the "Connection of Chemistry with Vegetable Physiology" for the Board of Agriculture, had been appointed by the Board Professor of Chemical Agriculture, with the duty—besides that of delivering annual courses of lectures—of analysing soils and manures at fixed fees for those who required such work. Davy had been preceded by Duhamel in France, where science —especially chemical science—was ahead of English knowledge; but the work of Davy soon surpassed that of his foreign rivals.*

The question of stock-raising never seems to have received any attention at all from the Society, and this is rather remarkable, because the successful experiments of Bakewell —commenced just about the time the Society was established—had attracted a great deal of attention, and had been followed up by numerous breeders of stock, cattle as well as sheep, all over the country. He was the first to indicate and to emphasise the necessity for proper selection in breeding, and the principles he laid down had the greatest possible effect in improving the character of British stock. George III. was an enthusiastic farmer and breeder, and many of the great landowners were devoting themselves to what was really the scientific raising of new breeds of sheep and cattle. All this, however, seems to have been regarded as outside the Society's province. There are occasional papers in the *Transactions* on feeding cattle, horses and sheep, on treating their various illnesses, etc. Arthur Young had a gold medal in 1769 (his first medal from the Society) for his system of fattening hogs, and from time to time a few unimportant premiums of a like nature were offered and bestowed; but, on the whole, the Society appears to have left this important subject severely alone.

Very many other objects were suggested in the Society's lists, or received premiums when submitted to the Society's notice. One of the most important of these was the reclamation of land from the sea, and there is a long list of those who received medals for such additions to the cultivable area in many places on the coast. The cultivation and improvement of waste land, the proper rotation of crops on

* See a life of Davy," by H. B. Wheatley, *Journal of the Royal Agricultural Society*, Vol. LXV. (1904) p. 1; also "Humphry Davy," by Sir Edward Thorpe (1896), pp. 94-99.

different soils, irrigation, the destruction of insect pests, methods of marking sheep so as to avoid the use of tar, harvesting crops in wet weather, the draining of land, were all matters to which attention was directed, and on which, from 1760 till about 1830, considerable amounts of money were expended. Bee culture was at one time (from 1760 to 1770) one of the minor industries that was warmly supported, and a large number of small prizes were given for keeping bees, and for producing wax and honey. Beeswax was then a more important article than it is now, as it was practically the only material available for the best candles.

By the end of the second decade of the nineteenth century the value and importance of the Society's agricultural work had greatly fallen off. In the preface to the volume of *Transactions* for 1819 (Vol. XXXVII.) we find a suggestion that "The object of the Society in the early and enlightened liberality with which they fostered the most important of the practical arts, agriculture, has, for the most part, been accomplished." The fact probably was that while the prosperity of the Society was at this time waning, the attention of its most active supporters was directed to other subjects than agriculture, and it did not appeal specially to them. At all events, from this time forward the Society was content for the most part to leave to other agencies the direction of agricultural progress. After this date, though occasional rewards were given for agricultural implements, they were neither numerous nor important. A few years later (in 1827), in place of the various detailed descriptions of apparatus which were required, the premium list contains only a general offer of rewards for "machines for performing any agricultural operations," and eventually the prizes seem to lapse altogether. The work had indeed been taken up by another agency. The "Board of Agriculture" had been established in 1793, and had carried on a not very valuable life till 1822. It was not really a Government department, but a sort of independent commission, enjoying a subsidy of £3,000 a year from the State. It had the good fortune to secure Arthur Young as its secretary, and if he had had a free hand it might have effected more useful work; but for the first part of his tenure of his office he was hampered by the proceedings of the chairman, Sir John Sinclair, whose influence had obtained from Pitt the Treasury grant by which the Board was established, and after 1808 he was incapacitated by blindness and old age. The Board produced one valuable piece of work in the "Statistical Surveys" of the counties of England, and it did good service when, as above mentioned, it appointed Davy its professor. It followed the example of the Society by offering premiums, when the time for such offers had passed away, and beyond this it really did very little. It is probable that the fact of the Board's existence diminished the Society's interest in agriculture, and made its agricultural work less necessary.*

Soon after the Board was abolished, a very different institution for the promotion of agricultural science came into being, for the Royal Agricultural Society was founded in 1838. From its first start it secured the support of all interested in the subject, and was at once recognised as the fit representative of British agriculture. From that date there was nothing more for the Society of Arts to do. But until the interests of this great industry passed into its competent hands it can be truly said that they were well looked after by the older Society. Amongst all its multifarious objects there were none more zealously pursued than those associated with agriculture. "Nor," in the words of the writer of the above-quoted preface—probably Arthur Aikin—"is it unjust to suppose that the unexampled rapidity with which the art of cultivation has advanced to its present state is in no small degree owing to the protection originally conferred by this institution."

THE NATIONAL LABOUR EXCHANGES.†

By Robert A-Ababrelton, F.R.G.S., F.S.S.

The Labour Exchanges under the control of the Board of Trade are authorised by the "Labour Exchanges Act, 1909." These Government Exchanges commenced on February 1st, 1910. On that day some fifty-eight Exchanges were opened. During that month the number rapidly increased, about ninety being at work by the first day of the following month. Since then others have been added, so that some 230 are open in Britain at the present time; and it is officially anticipated that there will probably be 300 in operation by the end of this year.

The old Labour Bureaux, or Employment Agencies—started with the best intentions by Distress Committees in their endeavour to find occupation for the unemployed, who were clamorously insisting that work of some kind

* An account of the Board of Agriculture, by Sir Ernest Clarke, will be found in the *Journal of the Royal Agricultural Society*, Vol. IX. (Third Series, 1898) p. 8.

† Paper read at the Economic Section of the British Association, Portsmouth, September 1st, 1911.

must be found for them—whilst directing public attention to the necessity for properly organised National Labour Exchanges, were also the cause of a general idea that only casual or unskilled labour would be registered therein, and consequently that skilled workmen would be unable to secure employment through the Government Exchanges.

At first considerable difficulty was experienced thereby, both in persuading employers to notify vacancies for skilled labour, and also in persuading skilled workmen to apply for employment at the Exchanges. Fortunately these difficulties have been rapidly overcome on both sides. Skilled workers are now applying in larger numbers each week. During May of this year, out of a total of 7,052 vacancies filled in the building trade, only 1,004 (just over 14 per cent.) were by unskilled men, the remainder being skilled workmen. In the engineering and machine-making trades, the proportion was 9·7 per cent. labourers, and 90·3 per cent. other workmen.

It was also necessary, at the very beginning, to grapple with the dislike of the workmen to have anything to do with an organisation which might be supposed somewhat to favour the employers, and at the same time to make employers understand that the Labour Exchanges had no bias in favour of the workmen, but were absolutely fair to both parties. Advisory trade committees were set up in connection with the Labour Exchanges, the membership thereon being equally divided between employers and workmen, so that each side is properly represented. Instead of the Board of Trade appointing the members entirely of its own motion, the trades organisations are consulted, and asked to nominate those who are to represent them on these committees.

It will probably be remembered that very soon after last year's session of the British Association in Sheffield, the Trade Union Congress was held in that city, and some strong remarks were made by certain leaders against the Labour Exchanges established by the Government. The principal complaints were that the Labour Exchanges were becoming agencies for procuring underpaid labour, and that, by favouring employers, they were undermining Trade Unionism. These matters were satisfactorily answered shortly afterwards, when the complaints were formally laid before the Board of Trade, and experience gained since has proved such complaints to be unfounded. The Labour Exchanges do not interfere between workmen and employers in the matter of wages or anything else. They do not manufacture vacancies, start relief works, or dispense charity in cases of distress. They merely act as intermediaries between workpeople seeking employment and employers wanting workers. There is, however, one class of labour which is excluded from the operations of the Labour Exchanges, namely, indoor domestic servants. Until the present instructions are altered, the servants' registry, with its fees, is the only registration office open to domestic servants seeking employment.

There are no fees chargeable at any Government Labour Exchange against either employer or employed. The employer is invited to notify the nearest Exchange of any vacancies in his establishment (except, of course, for indoor domestic servants), and he can do so by means of a postcard supplied to him, which is officially stamped. If he sends a postcard or letter, or messenger, or communicates by telephone or otherwise, the Exchange duly registers his requirements directly they are received. As soon as possible, from amongst the applicants registered, the Exchange will send him those men who appear to be the best qualified to perform the work required. If so desired, the employer or his foreman can interview the men at the Exchange itself. If workpeople of the kind needed are not registered locally, they can probably be obtained from another locality. The Exchanges are continually in communication with each other and with the central offices for that purpose. Suitable applicants may also be specially notified. I am distincly informed by managers and other Labour Exchange authorities, that the only qualification taken into consideration in submitting applicants to an employer is the industrial suitability of the workmen for the work offered, and that no regard is paid by the Exchange to other considerations, not even as to how long the applicant has been registered.

The employer retains his entire freedom of selection. He is even at liberty to let the Exchange know of any particular man whom he wishes to interview, and if that man is available he will be notified accordingly. The employer is expected to inform the Exchange of any persons engaged by him through its agency. Employers are now becoming so satisfied with the working of the Exchanges that they are making it a rule only to engage men through the Exchanges. Nearly five thousand enamelled plates giving this notice have already been issued and affixed to warehouse gates, etc.

I have visited Exchanges *incognito*, and have found that the applicant for employment need not fear, by going to a Labour Exchange, that he will be made to feel he is under any obligation to the authorities. He is not thereby seeking relief, or proclaiming himself to be an individual in distress. If he has had any experience of the ways of the officials of Distress Committees, he will be agreeably surprised. He will now find himself treated by the official at the counter more like a friend or comrade. All necessary questions are put to him quietly and sympathetically. He is not sharply questioned as to his past life or his domestic affairs; he is not asked to disclose any private matters; the object of the inquirer is merely to discover, as far as he possibly can, for what work the applicant is most suitable, and whether he will be likely to fulfil the requirements of certain vacant posts. From long practice, the officials are very apt at gathering what will probably be most suitable for the applicant under present-day conditions. It may be that he has fallen out of work because

APPLICATIONS RECEIVED, VACANCIES NOTIFIED, AND VACANCIES FILLED DURING: (1) The month of February, 1910; (2) The period of eleven months from February 1st, 1910, to December 31st, 1910, with average per month; and (3) The five weeks ended June 30th, 1911.

Period.	Applications Received.					Vacancies Notified.					Vacancies Filled.				
	Men.	Boys.	Women.	Girls.	Total.	Men.	Boys.	Women.	Girls.	Total.	Men.	Boys.	Women.	Girls.	Total.
February, 1910 . . .	179,062	14,479	18,961	4,311	216,813	12,156	2,427	5,090	1,520	21,193	8,180	1,715	2,053	680	12,628†
February 1st to December 31st, 1910 .	1,153,264	126,058	246,720	62,492	1,588,534	297,275	49,972	85,677	26,019	458,943	253,290	38,702	62,764	19,557	374,313‡
Average per month .	104,842	11,459	22,429	5,681	144,412	27,025	4,542	7,788	2,365	41,722	23,026	3,518	5,705	1,777	34,028‡
Five weeks ended June 30th, 1911* . . .	106,952	14,990	35,534	9,165	166,641	41,485	10,158	18,702	5,148	75,493	33,670	7,257	14,362	3,965	59,254§

* These figures are not comparable with the figures for 1910, because certain casual occupations included in the figures for that year are not included in the General Register for 1911, but are shown separately in the special returns relating to the Casual Register.

† 59 per cent. ‡ 81 per cent. § 78 per cent.

Period.	Casual Register (including certain occupations of an essentially casual nature).								
	Applicants Registered.			Applicants Given Work.			Number of Jobs.		
	Men.	Women.	Total.	Men.	Women.	Total.	Men.	Women.	Total.
Five weeks ended June 30th, 1911 . .	2,006	2,559	4,565	1,289	1,199	2,488 (54%)	10,755	1,687	12,462

he belongs to what may be termed a "dying" trade, such as coach-building, and that there is a growing industry, such as motor-car building, into which he could be introduced. There is no hesitation in offering similar advice to suitable men. If any questions are asked which it is inconvenient for the applicant to answer, he need not reply to them; but he is told that the fuller the information given, the greater the chance of suitable employment being found for him. The particulars obtained are entered on a "B" registration card, which is only filled up by the Exchange officials, and is treated according to the card-index system, the occupations of the applicants being elaborately subdivided for purposes of easy and rapid reference. If there are any suitable vacancies on the list, the applicant is at once informed of them, and he can be sent off immediately to the employer with a green identification card duly filled up by the official, who encloses it in a sealed green envelope addressed to the employer.

If the bearer of the identification card is engaged by the employer, the latter simply signs the card as "engaged," and drops it into the post. It is already stamped officially, and addressed to the manager of the Exchange from which it emanated. Until the card is received from the employer, or other information obtained disposing of the matter, the situation is considered open. If the employer does not engage the bearer, his identification card is handed back to him, and the applicant is expected to notify the result to the Exchange as quickly as possible. This he may do, either by calling there, or by posting the card. As it is not signed by the employer as "engaged," the officials know that for some reason the applicant has not been chosen.

To save time and trouble to himself each applicant is asked to register at the Exchange nearest to his home. As this is largely a matter for his own convenience, considerable latitude is allowed. For instance, persons usually employed in the City of London may register at the City Exchange instead of near their own homes, if they wish. This simple "registration" of an applicant lasts only a week, thus keeping the applicant in touch with the Exchange for "re-registration," if he has not been "placed" before that period has expired. He is generally asked to present himself at the Exchange once a week whilst disengaged. He may, however, call there as often as he pleases, within reasonable limits. The officials are generally able to tell him the best times to look in for information as to suitable vacancies. These are also notified in the windows of the Exchange.

The employer and the workman are quite free to make their own bargain, and no workman is prejudiced as regards his chance of future employment because he has refused a vacancy owing to some trade dispute, or because the wages offered were insufficient. If a strike or dispute is known to exist, the applicant is informed thereof, and is left at liberty to apply for the vacancy or not, as he may think proper. Directly an applicant obtains employment, either through his own efforts or by means of the Exchange, he should fill up his own registration card, which is officially stamped, and post it, so that it may be known he is no longer seeking employment.

Should there be work awaiting an applicant at a considerable distance, the Exchange will take the matter in hand, and, if an engagement results, will advance travelling expenses if circumstances require it. This is generally effected by means of a railway warrant. The mode of repayment is arranged between the parties concerned. During the first thirteen months of the existence of these Exchanges, a total sum of about £2,400 was advanced in this way in nearly 9,000 cases altogether. During that period £2,200 had been repaid.

To keep the statistics clear, if the applicant is not "placed" within a week, his "registration" expires; but he can "re-register" for as many other weeks as may be required. It should also be mentioned that sometimes an applicant who has been "placed" falls out of employment through temporary job, slackness of trade, or other cause. He may then be re-registered as "Re-registered after placing."

Sometimes an applicant prefers not to answer verbal questions when registering himself. In that case, he is given a form to fill up which is headed, "Answers to these questions are not compulsory, but it will be easier to send applicants to suitable employment if they fill in the form as completely as possible." The questions asked upon the form are name of applicant, address, age, work desired, last employer and previous employer, qualifications, when free, etc. From this form the official fills up the "B" registration card which is kept in the Exchange. These forms are also useful when many applicants are needing attention at the same time. Instead of keeping them all waiting they are asked to fill up these forms, which can then be dealt with expeditiously.

The opposition of the Trade Unions to the Labour Exchanges seems to be disappearing. Trade Union branches are now beginning to hold their meetings in rooms at the Exchanges, rather than in public-houses or other unsuitable places.

At each Exchange there is a separate department for women, with a female staff. Men and women enter by different doors, and are interviewed in entirely distinct rooms. To avoid mistake, it is perhaps necessary here to reiterate the fact that ordinary indoor domestic servants, female as well as male, are not allowed to make use of these Exchanges.

In general, there is also a separation between the skilled and unskilled of both sexes, and there is also a juvenile department for boys and girls below the age of seventeen. This juvenile department is subject to the rules made by the Board of Trade after consultation with the Board of Education so far as regards England and Wales, with the Scottish Education Department so far as regards Scotland, and with the Lord Lieutenant

of Ireland so far as regards Ireland. Juveniles applying for employment are registered, and special advisory committees are formed for the purpose of giving information, advice, and assistance to boys and girls, and to their parents, with respect to choice of employment and other cognate matters.

This system of Labour Exchanges has now become national. It is divided into ten territorial divisions, each with a central office or clearing house. These central offices are controlled by, and are in direct communication with, the chief central office in London. There must always be a certain amount of unemployment, even under good conditions. A workman finishes a job and is on the look-out for another. Until he finds it, he is one of the unemployed. The great aim of the Labour Exchange is to minimise that period of unemployment, and to abolish unnecessary tramping about in search of work. Mr. Beveridge, who is now the Director of these Labour Exchanges, in his valuable work on "Unemployment," states during the good year 1890 the proportion unemployed in the engineering trades at some time during the year was 21·4 per cent., whilst in the bad year 1893, the percentage only rose to 26·4. It will be interesting to note the percentages in good years and bad years when these Exchanges are in full operation. They are now filling over 10,000 vacancies each week. These are mostly for skilled labour.

Those who direct the operations of the Labour Exchanges are to be congratulated on the great adaptability to circumstances displayed in their working. The different entrances for men and women, and for employers and employed, the separate staffs for the different departments, and the separation of the skilled and unskilled, are instances in point. The Exchanges are generally open from Monday to Friday, from eight in the morning till five in the afternoon. On Saturdays they close earlier. But where a change is necessary, it is speedily made. One Exchange opens in the morning at four o'clock for the convenience of workmen. In the textile area in Manchester some Exchanges are open at six o'clock. All these early openings are conducted by a relay of staff.

Now that the value of these Exchanges is being realised, the number of employers notifying vacancies is continually rising, and a large measure of support is increasingly given by other Government Departments. In course of time, one may anticipate that only the "ne'er-do-wells," the "undesirables," and those who are called "wasters" in the British oversea dominions, will shun these Exchanges. Then every respectable workman or workwoman seeking employment would apply there as a matter of course, and every employer in want of workpeople would there make known his requirements. The great prejudice throughout the Dominions oversea against anything which can be called "interference" on the part of the Motherland, is well known. So is the Colonial fear that the Colonies may be made the dumping-ground for "undesirables" from this country, if the Labour Exchanges are permitted to extend their operations Oversea.

In these days of advanced ideas, surely one may be permitted to look forward confidently to a time when this prejudice, like other prejudices against the Exchanges, shall have faded away, and each portion of the British dominions will be doing its proper part in enabling a Grand Central Clearing House for Labour to overcome the evil of unemployment throughout the British Sovereignty, by a still greater national scheme working on the present lines of strict impartiality between employers and employed.

To afford some idea of the ordinary work of the Labour Exchanges, a table is printed giving the number of applications received, vacancies notified, and vacancies filled during certain periods. The percentage of vacancies filled rose from 59 per cent. on the first month's working to 81 per cent. on the average during 1910. It still varies, but appears to be keeping between 80 and 90 per cent. on the ordinary register at the present time.

The cost of the Labour Exchanges was recently stated in Parliament to be about £250,000 per annum. At present a considerable sum has to be found for initial expenditure, which will not recur. Some time must elapse before it will be possible to give a trustworthy estimate of the annual cost to the nation for this service.

Being in a position to obtain early and accurate information on the spot in cases of labour troubles, the usefulness of the Labour Exchanges is thereby largely increased. This latter work is done unobtrusively but effectively.

Owing to limitation of time it has been impossible to do more than mention several points which deserve fuller consideration.

THE PRODUCTION OF VEGETABLE IVORY IN ECUADOR.

An important industry in Ecuador lies in the export of vegetable ivory. The Spanish name is "coroza," but another similar nut is sometimes confused under the same designation. The fruit of the tagua palm furnishes this article of commerce, which has proved to be an excellent substitute for the elephant tusk product, and has been found useful in other ways. The tree grows wild along the west coast of South America, from Panama, through Colombia, Ecuador, and Peru. It is a stunted palm fern, growing from ten to twenty feet high, with a very short trunk, which is crowned with fronds of large bright green feathery leaves. In blossom the flowers give off a strong perfume, and the fruit is somewhat similar to the cocoanut, growing from four to nine to the tree. The fruit weighs nearly twenty pounds, grows to about the size of a man's head, and consists of a woody, fibrous, wart-covered wall, that encloses the seeds proper, which are of hard white composition, small potato sized, fine grained, and approaching real ivory in its characteristics. The head holds from six to nine seeds. According to a recent

report of the Pan-American Union, the seed, when very young, contains a clear insipid fluid, which serves the thirsty jungle traveller as water; but, like the cocoanut, this liquid quickly becomes milky and sweet flavoured, and then the small native animals find it most appetising. As climate affects the development of the tree, so a considerable variation will be found in the form and composition of the tagua nuts that grow under conditions of excessive rainfall, and those gathered in the dryer climates. As the plant grows wild and uncultivated, the time of bearing is not accurately known, but it is judged to be about the sixth year, and the life of the tree is estimated at from fifty to one hundred years. Natives gather the fruit of the tree, taking those nuts found on the ground which are matured. Immature seeds have a soft spot in the centre, which makes them less valuable, so care must be exercised in selection to avoid faulty fruit. The vegetable ivory is sold to a local merchant or exporter. The market price is governed by the competition of these exporters, which is resultant upon the European and American market. Some German firms keep quantities of the nuts stored, to be sold only when the market is most favourable. The principal use of vegetable ivory is the manufacture of buttons. Some vegetable ivory is used in making umbrella handles, chessmen, card counters, and similar articles that are also made from the dentine ivory, but the largest proportion by far of the vegetable product is bought up, to be turned into buttons. Turning out ivory buttons is an industry that gives employment to many persons in Europe and the United States. The process of changing the dried tagua seed into fancy waistcoat buttons is varied, complicated, and is carried on in extensive plants fitted with many different kinds of special machinery. The average annual export of vegetable ivory from Ecuador is 20,000 tons. Colombia has a fair share of the trade, with yearly increasing exports from Cartagena and Savanilla. Although in recent years a limited amount of this product has been sent out of Africa, yet the real home of the tagua palm is Central and South America, where it is a considerable source of wealth to the countries producing it.

ITALIAN TOMATO PRODUCTS.

The province of Naples has for years been noted for the production of a species of tomato specially suited for the manufacture of tomato sauce, extract, and paste. The fruit is small, thin skinned, free of fibre, and has small seeds, and a special flavour that is greatly relished by the Italians when prepared as a sauce to be eaten with macaroni and other farinaceous products. In the manufacture of tomato sauce and paste the fruit used in the preparation is fully ripe, the unripe fruit being set aside in baskets to ripen before being used. Speckled or mouldy fruit is placed in a special oven, dried, and afterwards made into an inferior class of thick tomato paste, which is not exported. The United States Consul at Naples says that it is the custom to prepare the fruit within a day after it is gathered. It is first carefully sorted, and then washed in hot water. Afterwards it is sorted again and washed in cold water, then automatically carried to the tables to be peeled. The residual parts of the fruit, such as skins, are automatically dried, in some cases to obtain cellulose. Oil is extracted from the seeds. Often the peels are sold for food for cattle or for fertilisers. The waste materials are said not to enter into the composition of the product. In the process of manufacture the fruit is pulped by air blasts as needed, and is then run into automatic boxes with double bottoms, the lower compartment of which is filled with steam, which maintains the product at a temperature of about 176° F. The concentration is effected previously by means of a vacuum. After being cooked it is canned immediately in tins which have first been submitted to sterilisation, by means of steam at 194° F. for thirty minutes. Then the tins are closed and sterilised again for another twenty minutes at a temperature of 230° F. Whether fermentation is desirable in the preparation of these products appears to be a matter of opinion among the manufacturers. One proprietor has stated that he endeavoured to prevent fermentation, as it affects the tins, and a large exporter stated that fermentation is sought in the preparation of these products. In one method, fermentation is brought about by a slow process of heating. Another provokes it by the use of selected germs. After the fermentation is produced, it is checked by the addition of salt in small quantities. Each time the work is suspended all vessels that have come into contact with the fruit at any stage of the manufacture are washed with a solution of bisulphide of soda, with boiling water, and finally with cold water.

THE CANE INDUSTRY OF THE SOUTH CHINA COAST.

There is a considerable trade carried on between the South China coast and Europe, and the United States, in fancy cane materials, and there is some confusion as to the exact nomenclature of these materials. For example, what is known in Europe as a "Tonkin stick" is unknown in Hong-Kong by that name, while among some manufacturers of Europe and the United States, what are known in China as "Annamite sticks," are taken to be what are known in China as quite another cane. In general, the trade is divided into two lines—those known in China as simply "canes," or sometimes as "Tsinglee canes," and generally identified with the name "Tonkin stick," and the "Annamite sticks," also known as "Partridge canes." The former are the well-known bamboos of the finer fishing-rod trade, which also are used for canes, umbrella handles, etc. The latter material is that peculiarly coloured cane with short sections, which has grains of dark colours running lengthwise, a bulbous root, usually used as a handle, and is a heavy wood

susceptible of a high polish. According to the American Consul-General at Hong-Kong, the name of "partridge stick," or "partridge cane," arises from the beautiful variegated colour of the cane. The name "Annamite stick" comes from the country or district in which the canes were first produced for the market. Most of this variety of material comes from Saigon and Indo-China generally at the present time. A considerable portion of the Tsinglee cane, or Tonkin stick, also comes from Indo-China, but at present the greater part is grown for the market in the delta lands of the Pearl River between Hong-Kong and Canton. It is difficult to generalise as to any portion of this trade, as prices and sales depend so largely upon special qualities that price quotations are always somewhat uncertain, the particular use for which the canes are required also determining the nature and quality of the stock. Of late, there has been an increasing demand for the "partridge canes," or "Annamite sticks." These are a variety of cane or bamboo which grows with a peculiarly swelled bulbous-like root, with few, if any, smaller roots projecting from it. The cane is pulled, not cut. When first pulled these small roots are removed, leaving the swelled end smooth, and when properly dried the root takes a high polish and forms the handle of the cane or umbrella stick. These canes have a dark brown colour generally, the colour running largely in lines up and down the cane. For some purposes this colour is the prime requisite of the stick. To have it regular and attractive the cane must be dried evenly, and must, of course, be free from imperfections due to disease or injury. The real colour of the cane does not readily appear upon its surface, and to ascertain or test it the buyer of the cane scratches the surface in a number of places, after it has attained some degree of dryness. The deeper the colour is found to be under the hard surface, the more valuable it is. The value of a stick is determined by its diameter, its colour, the quantity of root, its length, and its degree of dryness. At the present time about 4,000,000 "partridge canes" and 25,000,000 "Tsinglee" or "Tonkin canes" are exported from Hong-Kong annually.

THE JERKED BEEF INDUSTRY OF URUGUAY.

Some idea of the magnitude of the jerked beef industry may be gained when it is known that in Uruguay alone there are twenty-three establishments called "saladeros," where the preparation is carried on, while in the river region of Argentina and Brazil they number twenty-two, giving employment to thousands of men. It is stated that the persons employed in this industry are unable to eat meat of any kind during the killing season, owing to the constant odour of fresh blood about them. The number of cattle killed at the saladeros of the River Plate region, consisting of Uruguay, Southern Brazil and Argentina, in 1908, was 740,800; in 1909, 1,062,800; in 1910, 1,233,208; and in 1911 up to May, 1,024,400. In the establishment of saladeros where the cattle are slaughtered, and the beef cured, a piece of land several acres in extent is selected, on which are erected the buildings needed for this industry. The principal structure is usually about 175 feet by 100 feet, and 40 feet high, with a brick foundation, the sides of brick, pine, or galvanised iron, more or less open and covered with a corrugated iron roof. In an enclosure at one end the cattle are killed by driving a knife-blade into the spinal cord just behind the base of the skull. The animal is then carried into the building and dropped on the cement floor, where the hide is dexterously removed and the carcase elevated to a travelling tackle running on a trolley cable. The United States Consul at Montevideo says that the usual method is followed of removing the waste and quartering, the bones being removed so skilfully that the flesh, after a few slashings, forms a large, flat, single piece, which is allowed to hang for a few hours for the animal heat to pass out. It is then thrown into a large vat in the floor containing a very strong brine, where it remains for several hours, to be afterwards piled between layers of salt. After a varying period of time the meat is removed to the open air, where it is again stacked and salted, the drying process continuing there for several months. Acres are covered with these piles of meat to a height of ten feet, salt frequently being thrown over the surface. If rainy weather appears the meat is covered with a strong tarpaulin, although windy, cloudy weather is preferred to sunshine. When ready for the market "tassajo" is black in colour, a few feet square, and an inch or two in thickness, and as hard as sole leather. Very little tasssajo is eaten in Uruguay, the greater portion being exported to Brazil, Cuba and Porto Rico, where it is eaten raw, or boiled for some hours, and is preferred to a choice steak. Near the principal building is a smaller one, used for curing and storing hides. The floor is of cement, into which are sunk several large tanks half-filled with brine in which a certain quantity of corrosive chloride of mercury has been dissolved. After removal from the animals, the hides are thrown into the vats, remaining thirty hours, and are then spread out on the floor, one above another, and well salted. After curing for some days, the hides are baled ready for export. Another building in close proximity contains the boiling-room, where the fat is extracted from the bones, head and intestines, to be made into soap and candles.

HOME INDUSTRIES.

Railway Workers and the Public.—It is not very surprising that the report of the Railway Commissioners has given satisfaction to neither side. At present the companies are silent, but the representatives of the men are discontented, and there are renewed threats of a strike. Meantime the Great Western Railway Company is considering a scheme to improve the wages of their men belonging

to the lower grades, and there is pretty general agreement that the position of porters, carmen, shunters, checkers, and the variety of other occupations engaged in handling and forwarding goods must be improved. The problem is how to do it. Where is the money to come from? All the railway companies are not in the happy position of the Great Western. Nor is it likely that the public would readily consent to reduction of workmen's trains, week-end tickets, and excursion facilities. It was suggested before the Railway Strike Commission sat that if the companies found that their recommendations were to cost them much they should have the right to call upon the Government to sanction increased rates. But the Government may well hesitate before they assent to that demand, for it would mean an agitation on the part of the railway users of a very formidable kind. The complaint of the trading classes is that as matters stand they are seriously handicapped in competition with trade rivals abroad by the high railway rates they have to pay, and if these rates were increased it would be a very serious matter. It is not easy to see a way out of the difficulty, for three things are certain: (1) that large numbers of the railway workers are much underpaid, (2) that the present return upon capital invested in railways is less than it ought to be, and (3) that traders cannot afford to pay higher railway rates.

The Tobacco Trust.—The figures relating to the number of licensed tobacco manufacturers continue to decrease. Year by year since 1900 they have lessened. In that year they numbered 502, in 1910 they had fallen to 383, the official estimate for 1911 is from 340 to 345. The British tobacco manufacturing trade is divided into two parts—the staple trade, comprising fully one half (roll, twist, and shag retailing at 3½*d.* per oz.), and a proprietary trade, which is as profitable as the staple trade is the reverse. This proprietary trade consists of package cigarettes and packet fancy tobaccos, retailing at various prices quite out of keeping with their intrinsic values. So profitable is this proprietary trade that when the duty was increased by eightpence per pound it was not added to the retail price of certain well-known proprietary brands, the reason for this being that the articles in question were profit-bearing over and above eightpence per pound. On the other hand profits on the raw material are said rarely to go much beyond a halfpenny per pound, nor is it possible for it to rise very much in price. It is suggested that the salvation of the independent manufacturers would be found in reducing the duty to the point which will permit the sale to the workingman of an ounce of tobacco for twopence-halfpenny (it now pays duty relatively to the amount of about ninepence as against fourpence-halfpenny in the shilling spent by the richer consumer), and in supplementing it by an *ad valorem* stamp duty on cigarettes, cigars and tobacco, loose and in packages, based on their retail price to the consumer.

The Sugar Industry.—The statistical position of sugar does not suggest the likelihood of any early or considerable fall in prices. At the time of writing the price of 88 beet sugar is over 17*s.* per cwt., as against 8*s.* 6*d.* a year ago. This doubling of the price is due to a diminution in the visible stocks, and the certainty of serious shortage in the coming crop. It is believed that the total yield this year will be about 2,000,000 tons short as compared with the actual harvest of the previous season, 8,095,000 tons. The European production of sugar in the current season will not be more than three-fourths of that of last season, and the normal consumption of the world steadily increases. And there is the serious diminution in the visible stocks and floating cargoes in Europe and America, which in the middle of the present month amounted to 665,957 tons as against 831,622 tons at the same date last year. As to cane sugar, the crops are not expected to be materially different from those of last year, with the exception of Cuba, where it is expected that the crop will exceed that of last year by at least 500,000 tons. The position is complicated by uncertainty as to the Russian bounty. Russia is the one country in Europe where the beet crop this year is largely in excess of that of last year. Russia has a surplus of half a million tons from her 1910 crop, and her present crop is so large that it is possible that, with the surplus on hand, she may have at least a million tons more than she can consume or dispose of in her regular trade with the non-Convention countries in the East. Now this, with the half million extra tons from Cuba would go far to put things straight. But here the Convention has to be reckoned with, which prevents Russia, without the express permission of the Convention countries, from exporting to them more than 200,000 tons in any one year. Russia has applied for permission to increase her exports. Will the Convention countries grant it? It is very doubtful whether Germany and France will consent.

Mill-Driving.—The Textile Mill-Driving Joint Committee has decided to conduct an investigation into the various forms of mill-driving, and the first step in the investigation will be the collection of statistical information about the various kinds of motive power used in the United Kingdom, the United States, Canada, and most of the countries on the Continent. After obtaining this information the committee will decide the future course of the investigation, which is intended to cover (1) the relative merits of the different motive powers; (2) the relative merits of the different methods adopted in electrical driving; and (3) the relative cost of power in relation to the output of material for different motive powers employed. The whole object of the investigation is to give the trade an authoritative report, not only on the relative merits of motive powers, but on the relative merits of distributing power. For the purpose of collecting preliminary statistics the Textile Institute has been divided into five sections,

and a separate sub-committee has been appointed for each. The sections are cotton, worsteds and woollens, linen, silks, and hemp and jute. A special sub-committee has also been formed to conduct the investigations outside the United Kingdom, to deal with all sections of the textile industry. The opinion is gaining ground that electrical driving is making greater progress abroad than in the United Kingdom. It is expected that the investigation will be of an exhaustive character, and that it will last for more than a year.

Automatic Sprinklers.—The use of automatic sprinklers in warehouses has increased considerably of late years, and the insurance companies grant discounts where these machines are used, amounting in some cases to as much as 80 per cent. of the premiums. These sprinklers have frequently demonstrated their value on the occasion of fires, and it is suggested that they would be more effective still if the practice of suspending large numbers of healds close under the sprinklers was abandoned. In most buildings it would not be a very difficult matter to arrange for the healds to be lowered so as to allow the sprinklers room to distribute water effectively. Another suggestion is that separate buildings should be provided for the storage of healds, but in premises let to a number of tenants there are obstacles in the way. Moreover, the insurance companies do not make any allowance for this separate storage, which seems a little surprising when the inflammable nature of healds is remembered.

The Pit-Brow Women.—It is natural that Mr. Smillie's statement at the Conference of the Miners' Federation is attracting attention. As president of the conference Mr. Smillie defended the resolution to forbid women working at the pit brow, and said: "They were not ashamed for wishing to keep women off the pit bank, from the laborious, unhealthy employment, in order that many of their elderly men might find employment when they were no longer able to do full work underground." The obvious retort of the suffragist is that the real reason why workingmen object to women working at the pit brow is that they want the work for men. The case for the women is put very well by Miss Alice Kemp, who says: "These women have to live, and are among the five million wage-earning women in this country. Often the men who talk so glibly of the 'home as the woman's sphere' are precisely those who entice her out of that same 'sphere' by offering her equal work with man at half his pay. With regard to this 'laborious, unhealthy employment,' it has been stated that many of the women (at Wigan) have left the mill on account of ill-health and taken up work on the pit brow, and have greatly benefited by the change. This is not to be wondered at. From the crowded, stifling room, with closed windows and intense artificial heating, their life is now passed in the open air, and has a certain amount of movement in it." Miss Kemp goes on to say that some time ago Miss King-May, an expert in physical culture and a trained masseuse, gave up her Easter holiday of a fortnight in order that she might test the healthiness of this occupation for women. She herself worked at the pit brow, and came to the conclusion that the strain upon the women was by no means too heavy, and that the outdoor life gave vigour and robustness.

CORRESPONDENCE.

THE AMETHYST, ITS VIRTUES, AND ITS NAME.

I am moved to contribute an illustrative comment on certain statements as to the etymology of the word "Amethyst," and the imputed mystical properties of the stone [both the silicious, and the aluminious], made by Mr. Alfred E. H. Tutton, in his Lecture on "Rock Crystal," coll. 1 and 2, page 1092, published in yesterday's issue of the *Journal of the Royal Society of Arts.*

The Amethyst is the *al martas* of the Arabs, the Tamil *sugandi*, and Cyngalese *skuandi;* these three Oriental names, each everywhere in India including two totally different stones, the silicious, or occidental Amethyst, and the aluminious, or "Oriental Amethyst," so phrased by European jewelers, a true corundum [Tamil *kurundam*], differing only in colour from the sapphire and the ruby, and so hard that, even in India, it is often, when decolorised, palmed off as a veritable diamond. Like all the "rock crystals," and all the true gems, or "precious stones," it has been used from the earliest antiquity throughout the East, as an amulet, talisman, phylactery, prophylactery, charm, etc. Its earliest mention, known to Europe, is in Exodus xxviii. 19, under the name of *achlamah;* and after that by Theophrastus, "Stones," xxxi., who is the first to name the stone "the Amethyst" —ἀμέθυσον; the name we find in "The Revelation of St. John the Divine," xxi. 20, in the form of ἀμέθυστος. Theophrastus, "Stones," xxxi., and Pliny, "Natural History," xxxvii. 9 (40), and ix. 65 (39), are the only two classical writers of authority on its alleged virtues in the practice of sympathetic magic; while Plutarch, ii. 462, C. Dionysius Periegetes, 1122, etc., count for nothing in the controversy. Theophrastus says expressly that the stone is called "the Amethyst, [*i.e.*, 'anti(vinous)drunkenness'], because [on the magical principle of 'like cures likeness'] it is wine-coloured." Pliny gives the word the same derivation, but expressly ridicules as preposterous the pretence of the magicians who would persuade people that it is a preventive of surcharged potations. Yet there must have been something in the belief, for believers in it, or surely we should not so often find the Amethyst graven with Bacchanalian words, and symbols, and subjects, throughout the whole classical period of the glorious glyptic art of Greece and Rome, as in the Μέθη ring of "Great Cæsar's"

greater Cleopatra. If you wore such a ring, there would be a constraint against your filling up your wine cup to intoxication. There are many things in which, in this way, it is good to believe, although you know them to be false, materially. Pliny enumerates several sorts of Amethyst, including one of the rich purple tint "called by the people of India, *socon*, the stone itself being called *socodion*." This is the "Oriental Amethyst" of our world; and with the instances before me of *corundum* being so named from the Tamil *kurundum*, and the Balas Ruby, from the Hindustani *Lal-i-Badakshan* ["The Red (stone) of Badakshan," on the Oxus], and Lapis-Lazuli from the Lajwardi mines of Persia, and Turquoise from Turkey, there can be no doubt of Pliny's *socon* being the Cyngalese *skuandi*, and his *socodion* the Tamil *sugandi*. And, to rush in where more responsible etymologists might fear to tread, I will adventure the suspicion, indeed, the suggestion, that the Arabic word *al martas*, which I find written also *al martees*, is none other but the very word "Amethyst" itself, modified in its passage through Egypt and Syria into Greece, where it was perfected to its final European form, in order to give it the full meaning in Greek suggested by the immemorial reputation of the stone as "a means of grace" in the pursuit of one of the most imperative of Pythagorean temperances.

Going back from what Pliny writes, xxxvii., of the Amethyst stone, to what he says, ix. 65 (37), about the pushful dyers of Rome, always on the rack, by mixing colours, in hope of blundering on some novelty of tint, hue, shade, or tone as a good advertisement ["nomen improbum"] of their skill, it is evident that the Amethyst dye he there describes [cf. Martial I. xcvii. 7] was also of the depth and lustre of the purple "Oriental Amethyst," and not of the washed-out purple of the European Amethyst; or of "fluor spar," our British "Blue-John."

GEORGE BIRDWOOD.

October 28th. 1911.

IMPERIAL COLONIAL DEVELOPMENT.

In continuation of the correspondence on this subject in the *Journal* of August 18th last, Mr. Enock's scheme of imperial colonial development, viz., the endowment of British municipalities with areas of colonial lands, appears to have been evolved from a conviction that, firstly, there is not as great a demand for artisans in the British overseas dominions as there should be; and, secondly, that Britain has an overplus of artisans for whom she has little or no use. If Mr. Enock's policy will remedy these defects, then I am heart and soul with him in the scheme.

Mr. Enock complains that the colonies are draining the old land of her best agricultural workers, and he likewise complains that they do not sufficiently encourage town workers. The reason for this is not far to seek. Australia has vast tracts of arable land. There is always a ready market in the world for the products of the soil. What is more natural than the anxiety of those responsible for the well-being of Australia to see this land under cultivation? To bring about this desire, Britain is called on for her yeomen.

As the land is settled the demand for artisans increases, and those who can afford to leave England do so. Every man who emigrates usually leaves a job to do so, and a vacancy is thus created for one of the poorer class to fill. Does Mr. Enock propose that the British municipalities should change the order of things—send the artisans first to build the houses and manufacture the machinery for potential settlers?

The course followed in settlement, at present, is something like this. Let us assume that the Land Department in Victoria have 100,000 acres of suitable land available. It is balloted for in 1,000 acre blocks, 100 farms. Of the 100 successful applicants, say, fifty are farm hands who have been working for wages for about five years, and having saved a little money desire to have a farm of their own. Thus fifty vacancies for farm labourers are created. To fill these vacancies Britain is drawn on. Does Mr. Enock propose under his scheme to put fifty artisans into the jobs?

To continue. The successful settlers desire to engage help for their farms. They intend doing most of the work themselves, but there are lots of little jobs that a youth or town labourer could do. Such settlers usually apply to the British Immigration League or the Immigration League of Australasia, both of which are doing good work in sending out lads from the home cities to Australian farms. No Government could do more than this without placing their country hopelessly in debt and incidentally penalising the settlers for whose benefit the money had been spent.

The British municipalities could only create a temporary demand for artisans, and the artisans thus would eventually be in as hopeless a position as if they had remained at home.

The demand for town workers can only keep pace with—it can never outstrip—land settlement in an agricultural country. To attempt to reverse this order of things is bad Imperialism, not to say a hopeless task. Imperial colonial development must be conducted on business lines.

The interest that Mr. Enock takes in this very important matter shows that he is a good Imperialist.

If from the ashes of our discussion there rises one practical idea to improve the condition of Britain's workers, and bring about a better understanding between the old land and her sons across the sea, I shall feel that not in vain have I suffered the bites of the famous Gold Coast sand-flies while penning this.

A. G. REID.

Obuasi, Gold Coast Colony.
October 5th, 1911.

Mr. Enock, to whom the foregoing letter has been submitted, writes as follows:—

It would seem from Mr. Reid's letter that he has not read my paper, given before the Society

where his objections are answered; or, if he has, he cannot, or will not, grasp the plan advocated. I have also gone fully into the subject in my book, "An Imperial Commonwealth," published last year.* The purpose is not to supply colonial farmers or manufacturers with labour—that will take care of itself—but to bring about an intensive system of "re-colonisation," making use of uninhabited colonial lands and surplus labour at home. Mr. Reid, like many others, falls at once into the error of supposing that it is intended to dump town labour into the colonies, unprovided for, and put it to work at the plough.

The purpose is to establish new communities which, as far as possible, would be self-supporting, and which would ask nothing from colonial governments beyond the land—either as a free grant or in purchase. Upon these new areas industries would be developed, both agricultural and industrial ones depending upon agriculture. In this no excess of artisan labour would be permitted. The only rational way of meeting the grave conditions in Britain, of surplus artisan labour (conditions not unknown in the colonies), will be by a system of "re-colonisation," as I venture to term it, where due regard is had to the proportion of land workers to hand workers. This, of course, is to some extent the "garden city" idea, but it will have to be carried into a broad "industry-planning" scheme.

Very well, the time is coming when this will be done at home; when it will be recognised that every human unit, under organisation, is of producing and national value. When that comes about there will be much less emigration, and the tendency of governmental legislation in England lies that way—in giving a freer access to the land. But what I want to do is to anticipate that time, creating new centres of industry overseas for our overcrowded people at home. Mere emigration alone will not accomplish it. The British ratepayer, like all others, expects to get something for his money. He is not prepared to assist in any scheme of emigration which gives no return for capital invested, and this is reflected in the attitude of the Government, which will not, so far, sanction any plan of State-aided emigration.

The purpose I put forward is one of mutual self-help and profit, under which every British municipality, city, or shire, would establish its own colony, of course under the colonial *régime*, and gradually merging into the colonial communities, except that the "property" continues to return an interest on the money and effort which established it from home.

It is at least strange that the self-governing dominions have not yet put into practice some analogous plan or organisation. Instead of this, they come into the highways and byways of the old country and take away what we can least spare—our land-working people and domestic servants. We may not grudge them this method, but it is time to supplement it. They want population. Australia is nearly stationary; Canada has just been disappointed of a million in her census; but I do not believe that in the future they will continue to obtain it from Great Britain under the present haphazard system of emigration. Under organised, reciprocal methods, there is a large reservoir of people which could be tapped—people of less adventurous class than the ordinary emigrant, and people without funds for emigration.

But it is not much use arguing this matter on theoretical grounds. The fact remains that at home we have a great mass of human material in our towns which cannot live in sufficiency.

My social work in the poor quarters of London shows a state of things which can only be described as appalling, and if "Empire" is to be more than a mockery to this class, it is time for action and not words. The following fact may interest your correspondent and others, to whom this letter is a reply (for many have written me on the subject). It is this. One of the London borough councils advertised about a month ago for a "handy man," at 25*s*. per week. They got 750 replies!

The remedy for these matters lies in the hands of the people themselves on the lines advocated, but initiative is necessary. The selfishness and apathy which have to be overcome are as strong in the dominions as at home, but if they could be cast off, and the wheels of some unselfish organisation set in motion, then we could enter on a new and impregnable Imperialism. Let us recognise the commercial value of every able-bodied citizen, and every acre of colonial territory. If your correspondent—and others—will adopt this view, perhaps the "sand-flies" which are troubling him will disperse.

C. Reginald Enock, F.R.G.S.

* Grant Richards, Ltd., London, 1910. 3*s*. 6*d*.

CANADIAN COINAGE.

With reference to the paragraph on this subject in the *Journal* of October 27th (p. 1104), the Rev. William C. Piercy writes that the letters "D.G." were omitted by pure inadvertence from the new Canadian cents, and that fresh dies were sent out to Canada directly the mistake was discovered.

NOTES ON BOOKS.

The Soya Bean of Manchuria. By Norman Shaw. Shanghai: Statistical Department of the Inspectorate-General of Customs; London: P. S. King & Son. 3*s*. net.

The Statistical Department of the Chinese Customs has for many years been in the habit of issuing publications on commercial subjects, and of supplying its Agencies in Europe and the United States with copies for the use of those who were interested in the subjects treated; but in consequence of the sudden and remarkable growth in commercial importance of the soya bean of

Manchuria, the Department has been induced to publish in a more general way this monograph, which is the work of Mr. Norman Shaw, of the Chinese Customs Service.

Although the soya bean grows well in many parts of the world, the soil and climate of Manchuria seem to suit it better than any others. It grows in great varieties, yellow, green, brown, black and mottled. Photographs of these species are given, and further developments towards red, orange, white and blue seem to be possible. After describing these various kinds, Mr. Shaw discusses the methods of cultivation, soil infestation, and yield, and then follows an extremely interesting section on the uses of the bean. A number of these are, of course, very familiar. The bean has long been used in the East as soy sauce, from which the name soya is derived; as chiang, the common diet of agricultural labourers; and as toufu, or bean-curd. Bean refuse is well known as a fertiliser or as a fattener of hogs; bean oil as an illuminant is still preferred by thrifty Chinese to kerosene, as requiring no special lamp; and beancake, again, is familiar for fertilising and for the feeding of stock. But not so familiar is the use of bean oil for waterproofing umbrellas, and, when mixed with lacquer, for manufacturing varnish and printing ink. And yet further uses have been discovered for the bean in Europe. German millers experiment with it for the making of brown bread; English manufacturers produce excellent bean biscuits; it is sought for by makers of margarine, soap, candles, and for cheese; and French culinary ingenuity has even, according to reports received, employed the bean as a substitute for coffee beans.

With all these uses it is hardly to be wondered at that the increase in the export trade of soya beans has during the last three or four years been quite extraordinary, and that the bean has, to quote the Statistical Secretary's Report on the Foreign Trade of China in 1909, "taken at a bound a position equal to that of tea in the list of exports, and, with the addition of beancake, even challenges the position of silk at the top of the list."

ANTOINE WATTEAU. By Camille Mauclair. London: Duckworth & Co. 1s. net.

This little volume forms part of Messrs. Duckworth & Co.'s Popular Library of Art. Mr. Mauclair is a devoted admirer of Watteau, and the book perhaps acquires some additional interest from the writer's determination to regard the master's work in the light of the disease which cut him off in the fulness of his powers. There can be little doubt that an ailment like consumption must have a great effect upon the sufferer's mind and point of view, and the frequency with which it has been associated with great talent, and even genius, invested it at one time with something like a halo of romance. Mr. Mauclair claims to have had special opportunities for studying the effect of the disease upon the artistic imagination, and he attributes the ethereal, poetic dreaminess, which he sees more especially in the painter's later work, to "the unsatisfied yearning of a consumptive, who is chaste and wishes to remain so."

Mr. Mauclair gives a very readable account of Watteau's life, of his early struggles, his frightful poverty, of his sudden leap into fame and comfort, and of his almost equally sudden death. The volume contains over thirty illustrations. If some of them are smudgy and indistinct, the wonder is not that they are not better but that they are as good as they are at the price.

GENERAL NOTES.

TEXTILE EDUCATION IN BRADFORD.—The new textile department of the Technical College of Bradford was opened on October 25th by Lord Rotherham. The cost of the building and equipment is estimated at £35,000. A full course of instruction will be provided in wool scouring, top production, yarn production, warping, dressing, weaving, dyeing, and finishing. The machinery installed is of the very latest description, and students will have every opportunity of studying various kinds of motive power. The opening of the department marks a very important step in the development of technical education in Bradford.

TUNNEL UNDER THE ELBE AT HAMBURG.—The tunnel under the Elbe at Hamburg was opened to the public on October 7th. This work, which connects the city of Hamburg with the suburb of Steinwarender, situated on an island in the river, and with the left bank of the Elbe, is 428 metres in length (1,404 feet). It occupied four years in construction, at a cost of 10½ million marks (£525,000).

CANADIAN DIAMONDS.—The chief mineralogist of the Canadian Geological Survey for the past few months has been studying the olivine-bearing rocks of Canada, which often contain asbestos, chromite, platinum, and, in some cases, diamonds. Some of his examinations were into chromite ore from the Montreal pit, near Black Lake. Until 1910 this mine was worked for chromite, and he has established beyond all doubt that this ore contains an appreciable proportion of diamonds in small crystals. The discovery may prove of economic value. The diamonds are too small to be of use as gems, their size being microscopic, but there are so many of them that it is a question whether or not it would pay to separate them as a by-product in the concentration of chromite, and sell them as diamond dust, which is much used in the cutting and polishing of diamonds and other gems.

CHINESE TEA-SEED OIL.—Tea-seed oil is the name applied to an oil expressed from the seed of the Camellia Sasanqua. This is not the tea-tree (*Camellia Thea*), nor can its leaves be used. It grows principally in Honan, but is found wherever the wood-oil tree grows. The seeds are gathered

in October, and the extracted oil usually reaches the market in Hankow about the middle of winter. It is used by the Chinese as a cooking oil, and costs in the market from thirty-one shillings to thirty-three shillings per picul of 133⅓ pounds. Hankow's exports of this oil to foreign countries and Chinese ports in 1909 were valued at £6,500, and during 1910 at £17,300.

THE FRENCH TOBACCO MONOPOLY.—The latest statistics concerning the French tobacco monopoly show that the receipts of every nature in 1909 amounted to £19,000,000, an increase of £360,000 over 1908. The sales of manufactured tobacco for the year aggregated £18,800,000, and the net profits £15,300,000. The export sales represented less than £400,000 in value. The commissions, or profits of the retailers, who act as agents of the Government, amounted in 1909 to £1,600,000, or 8·47 per cent. of the sales. The sum expended in France for tobacco consumption during the year was 10*s*. 10*d*. per caput; the average tobacco consumption per caput was 36·6 ounces; the retailers numbered 47,669, or one to each 817 inhabitants. The tobacco production of France is almost equal to the importation. The 1909 figures were as follows:—Total yield, 27,134 tons; value of crop, £900,000; number of planters, 48,395; area cultivated, 37,156 acres; average yield per acre, 1,610 pounds.

CHINESE POMELOS, OR GRAPE-FRUIT.—Various kinds of pomelos are grown extensively in southern China, all of which vary more or less widely from the American grape-fruit, although belonging to the same family. Those grown in Amoy are the largest, and are regarded by foreigners as the best produced in China. A smaller kind is grown in the Foochow district, many of which are shipped to Amoy, there given the Amoy "chop," and then returned to Foochow as imported Amoy pomelos. The object of this, of course, is to give an inferior fruit the benefit of the Amoy reputation. The Amoy pomelos compare favourably with the American fruit in point of size, are thick-skinned, comparatively juicy, but decidedly bitter. The Chinese themselves prefer the Kwangsi pomelo, which is smaller but sweeter.

THE WILD POTATO OF CHILI.—Some excellent results have been obtained by Professor Heckel in the experimental cultivation of the *Solanum maglia*, or wild potato of Chili, at Saint Jerome, near Marseilles. In a communication to the Académie des Sciences, the professor states that each plant produced on the average two kilogs (nearly 4½ lbs.) of tubers, which are of a violet colour. The average weight of each tuber was 350 to 380 grammes (12 to 13½ ounces). The wild potato under cultivation is very hardy, and less liable to cryptogamous diseases than the common variety grown in Europe. Specimens of every known variety of the wild potato found growing in South America, both on the sea coast as well as at high altitudes in the Andes, have been obtained for further experiments.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOVEMBER 6...Engineers, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 7.30 p.m. Mr. R. W. A. Brewer, "Two-cycle Engines."

Chemical Industry (London Section), at the Chemical Society's Rooms, Burlington House, W., 8 p.m. Dr. E. G. Acheson, "Deflocculation as affecting Lubrication."

Geographical, Burlington-gardens, W., 8.30 p.m. Dr. Fridtjof Nansen, "The Norsemen in America."

British Architects, 9, Conduit-street, W., 8.30 p.m. President's Opening Address.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. H. C. Bastian, "The Origin of Life Question."

TUESDAY, NOVEMBER 7...Alpine Club, 23, Savile-row, W., 8.30 p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Address by the President, Dr. W. C. Unwin.

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. W. T. Wilkinson, "The Difference in Reticulation of Gelatine obtained by the Use of various Chromates and Bichromates."

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Mr. R. I. Pocock, "Lantern Exhibition on the Moulting of the Arctic Fox." 2. Mr. D. Seth-Smith, "On the Moulting of the King Penguin (*Aptenodytes pennanti*) in the Society's Gardens." 3. Mr. T. E. Gunn, "On the Presence of Two Ovaries in certain British Birds, more especially the Falconidæ." 4. Professor P. P. Sushkin, "Ontogenetical Transformations of the Bill in *Ardea cinerea*." 5. Dr. A. D. Imms, "On some Collembola from India, Burma, and Ceylon, with a Catalogue of the Oriental Species of the Order."

Horticultural, Vincent-square, Westminster, S.W., 3 p.m. Mr. J. Hudson, "The Cultivation of the Fig in Pots."

WEDNESDAY, NOVEMBER 8...Biblical Archæology, 37, Great Russell-street, W.C., 4.30 p.m. Rev. Dr. Ball, "A Study in Biblical Philology."

Geological, Burlington House, W., 8 p.m. 1. Professor Edward Hull, "On the Interglacial Gravel-Beds of the Isle of Wight and South of England, and the Conditions of their Formation." 2. Mr. J. B. Scrivenor, "The Gopeng Beds of Kinta, Federated Malay States."

Automobile Engineers, at the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. Mr. H. E. Coffin, "Chassis Design."

Faraday Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Address, with Experiments, by Dr. E. G. Acheson.

Royal Society of Literature, 20, Hanover-square, W., 5.15 p.m. Lecture by Professor A. C. Benson.

THURSDAY, NOVEMBER 9...Child Study, 90, Buckingham Palace-road, S.W., 7.30 p.m. Professor W. Rippmann, "Psychology of Speech."

London Institution, Finsbury-circus, E.C., 6 p.m. Dr. Hans F. Gadow, "Life on the High Mountains of Mexico."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. G. C. Druce, "Birds and Beasts in Ecclesiastical Architecture."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Mr. W. T. Taylor, "Modern High Voltage Power Transformers in practice with special reference to a 'T' Three Unit System."

FRIDAY, NOVEMBER 10...Concrete Institute, 296, Vauxhall Bridge-road, S.W., 8 p.m. Presidential Address by Sir Henry Tanner.

Astronomical, Burlington House, 5 p.m.

Physical, Imperial College of Science, South Kensington, S.W., 5 p.m.

British Foundrymen's Association, Cannon-street Hotel, E.C., 8 p.m. Mr. F. J. Cook, "Physical Properties of Cast Iron."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

CANTOR LECTURES ON "BREWING."

The Cantor Lectures on "Brewing and Modern Science," by Professor Adrian J. Brown, M.Sc., F.R.S., have been reprinted from the *Journal*, and the pamphlets (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.

A full list of the Cantor Lectures which have been published separately, and are still on sale, can also be obtained on application to the Secretary.

ARRANGEMENTS FOR THE SESSION.

The Opening Meeting of the One Hundred and Fifty-Eighth Session will be held on Wednesday evening, November 15th, when an address will be delivered by LORD SANDERSON, G.C.B., K.C.M.G., I.S.O., Vice-President and Chairman of the Council. The chair will be taken at Eight o'clock.

The following arrangements have been made for meetings before Christmas:—

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

NOVEMBER 22. — JAMES DOUGLAS, LL.D., Past President Am.Inst. Mining Eng., "The Industrial Progress of the United States of America."

NOVEMBER 29. — A. E. BERRIMAN, "The Efficiency of the Aeroplane."

DECEMBER 6.—J. A. J. DE VILLIERS, "British Guiana and its Founder, Storm Van 's Gravesande." LORD REAY, G.C.S.I., G.C.I.E., LL.D., will preside.

DECEMBER 13.—W. YORATH LEWIS, M.Am. Soc.M.E., A.M.Inst.Mech.E., A.M.Inst.E.E., "Continuous Service in Passenger Transportation."

INDIAN SECTION.

Thursday afternoon, at 4.30 o'clock:—

DECEMBER 14.—J. TRAVERS JENKINS, Ph.D., D.Sc., Superintendent of the Lancashire and Western Sea Fisheries, "Fisheries of Bengal."

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

PROFESSOR VIVIAN B. LEWES, "The Carbonisation of Coal." Four Lectures.

Syllabus.

LECTURE I.—NOVEMBER 27.—*The Composition of Coal.*—Existing theories on the composition of coal and the chemistry of its formation—Humus and resin compounds found in lignites, and the action of heat upon them—The classification of coals, and the effect of composition on the products of decomposition by heat—Coking and non-coking coals.

LECTURE II. — DECEMBER 4. — *The Methods Employed in the Destructive Distillation of Coal.*—The changes which have taken place during the last century in the forms and settings of gas retorts —The developments of the last ten years and present position of the gas industry—The coke industry and the gradual development of the modern recovery plant—The influence of the retort or oven on the carbonisation.

LECTURE III. — DECEMBER 11. — *The Thermal Conditions existing during the Carbonisation of Coal.*—The heat of formation of coal—The work of Euchene, Mahler, and others—The cause of the endothermic nature of some coals—The thermal value of the reactions taking place in the retort—The losses of heat in a retort setting—The transmission of heat through the retort and charge—The effect of temperature and travel on the primary products of decomposition — The temperatures existing in retorts and ovens—Small charges and

full charges—The influences which lead to improvement in the products from full charges, chamber and vertical retorts.

LECTURE IV. — DECEMBER 18. — *The Possible Improvements in Carbonisation.*—The aims of the gas manager and coke producer—Experiments on low temperature distillation and their teaching—The rivalry existing between fully-charged retorts, vertical retorts, recovery ovens, and chamber carbonisation — The intermittent vertical retort *versus* the continuous vertical systems—The Settle-Padfield, Duckham-Woodall, and Glover-West processes—The ideals of carbonisation—The volume of gas due to primary and secondary reactions—The gasification of tar—The limitations of volume and quality of gas—The ends to keep in view in devising new processes of carbonisation.

Papers to be read after Christmas:—

CECIL THOMAS, "Gem Engraving."

F. MARTIN DUNCAN, "The Work of the Marine Biological Association."

H. A. ROBERTS, M.A., "The Relations of Science to Commerce and Industry."

JOHN NISBET, D.Oec., late Conservator of Forests, Burma, "The World's Decreasing Timber Supplies."

FRANK WARNER, "Silk."

CHARLES C. ALLOM, "The Development of Artistic Skill in the Applied Arts."

CYRIL DAVENPORT, "Illuminated MSS."

ERNEST KILBURN SCOTT, A.M.Inst.C.E., M.Inst.E.E., "The Manufacture of Nitrates from the Atmosphere."

CHARLES BRIGHT, M.Inst.E.E., "The Administration of the Imperial Telegraphs."

HAROLD COX, "The Interdependence of Morals and Economics."

PROFESSOR G. W. OSBORN HOWE, "Recent Progress in Radio-Telegraphy."

E. D. MOREL, "British Rule in Nigeria."

GORDON CRAIG, "Stage Illusion."

THEODORE E. SALVESEN, "The Whaling Industry of To-day."

LEONARD HILL, M.B., F.R.S., and MARTIN FLACK, M.A., M.B., B.Ch., "The Influence of Ozone in Ventilation."

E. A. GAIT, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

WALTER SAISE, D.Sc., M.Inst.C.E., F.G.S., "The Coal Industry and Collier Population of Bengal."

NEVILLE PRIESTLEY, Managing Director, South Indian Railway, "Indian Railways."

W. A. LEGG, M.Inst.C.E., "Irrigation in South Africa."

ALAN BURGOYNE, M.P., "Colonial Vine Culture."

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

January 18, February 8, March 14, April 25, May 16.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

January 30, February 27, March 26, May 7.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

VAUGHAN CORNISH, D.Sc., F.G.S., F.C.S., "Ocean-Waves, Sea-Beaches, and Sandbanks." Two Lectures.

January 22, 29.

LOUDON M. DOUGLAS, "The Meat Industry." Three Lectures.

February 5, 12, 19.

LUTHER HOOPER, "Hand-Loom Weaving." Three Lectures.

February 26, March 4, 11.

NOEL HEATON, F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

March 18, 25, April 1.

HOWARD LECTURES.

Monday evenings, at 8 o'clock:—

CAPTAIN H. R. SANKEY, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

JUVENILE LECTURES.

Wednesday afternoons, at 5 o'clock:—

CHARLES VERNON BOYS, F.R.S., "Soap Bubbles." Two Lectures.

January 3, 10.

EXAMINATIONS, 1911.

During the past year the subject of the value of examinations has come in for a good deal of discussion. This discussion was first started by Mr. Philip Hartog in the paper he read here on "Examinations in their Bearing on National Efficiency," and the value of Mr. Hartog's original paper was greatly enhanced by the remarks, equivalent, indeed, to a supplementary paper, by Lord Cromer from the chair. The discussion was continued at the last meeting of the British Association. Sir William Ramsay devoted a considerable portion of his presidential

address to the consideration of the value of examinations, and Dr. Welldon, in his address as President of the Educational Section, discussed the matter at still greater length, whilst Mr. Hartog himself carried the discussion a little further in a paper on "The Place of Examinations in Education," before the same section.

The consideration of the subject was, however, for the most part confined to the value of competitive examinations as a test of a candidate's qualifications for some particular post. The general result arrived at was much the same as had been acknowledged long before —that competitive examinations are a necessary and inevitable evil; an objectionable device for deciding the relative merits of candidates, which has to be retained until something better can be put in its place. In rare instances, such as the one mentioned by Lord Cromer, a substitute can be found. But when it comes to selecting a number of candidates for Government posts, it is a choice between favouritism and examination; and the latter system, on the whole, is the more popular, though it is a matter for argument which of the two systems provides the better results.

The examinations with which the Society is concerned are, of course, of a different class. The Society's examinations form part of an enormous system, the extent of which is, perhaps, hardly realised. It may be interesting to give some figures illustrative of the work done by the various bodies which undertake to provide examinations of a moderate standard in the various branches of knowledge.

These figures are taken from official sources, but are not official. It is probable that they are not wholly accurate. They are certainly not wholly complete. For instance, the Scotch Education Department hold annual examinations for their Intermediate and School-Leaving Certificates. In 1910, 4,093 of the former and 1,080 of the latter were awarded, but the numbers of the candidates are not published. At any rate the figures here given may serve as an indication of the number of students examined during the year 1910.

NUMBER OF CANDIDATES EXAMINED IN 1910.

	No. of Candidates.	
University of Oxford Local Examinations—		
Senior	11,780	
Junior	7,881	
Preliminary	3,136	
		22,797
University of Cambridge—		
Higher Local Examinations	834	
Preliminary (Boys)	2,947	
,, (Girls)	1,878	
Junior (Boys)	5,984	
,, (Girls)	3,374	
Senior (Boys)	3,885	
,, (Girls)	4,303	
		23,205
Oxford and Cambridge Schools Examinations Board—		
Higher Certificate	2,165	
School Certificate	662	
Lower Certificate	1,065	
		3,892
London University—		
Matriculation	5,396	
Senior School Examinations	912	
		6,308
Board of Education—		
Examinations in Science	67,327	
,, ,, Art	46,231	
		113,558
City and Guilds of London Institute (Technology—United Kingdom)		24,508
London Chamber of Commerce—		
Junior	7,230	
Senior	3,976	
Teacher's Diplomas	399	
		11,605
College of Preceptors—		
1st class (Senior)	892	
2nd ,, (Junior)	3,000	
3rd ,,	2,726	
Lower Forms	2,529	
		9,147
National Union of Teachers		14,410
Pitman's Shorthand Examinations—		
Teacher's Certificate		625
Lancashire and Cheshire Union of Institutes—		
Ordinary	25,918	
Course	15,821	
		41,739
		271,794

We thus get a total of 271,794 examinees. If to this we add the 27,330 examined by the Society in 1910, we have a total of 299,124—say, 300,000 candidates examined in elementary and secondary subjects during the year. To this must be added the results of all the university and professional examinations, and of all the competitive examinations for the Army, Home and Indian Civil Services, etc.

These figures certainly show that there is an enormous demand in this country for examinations, and that the demand is fully supplied. Most people will admit that whether examinations are, or are not desirable, the thing is

TABLE A.—DETAILS OF THE 1911 EXAMINATIONS.

Subjects.	Stage III.—Advanced.				Stage II.—Intermediate and Music.							Stage I.—Elementary.			Total number of papers worked in all stages.
	Papers worked.	1st class certificates.	2nd class certificates.	Not passed.	Papers worked.	1st class certificates.	2nd class certificates.	Music Certificates. Higher.	Music Certificates. Inter-mediate.	Music Certificates. Elemen-tary.	Not passed.	Papers worked.	Passed.	Not passed.	
Arithmetic	177	28	68	81	731	137	353	..	..	..	241	1,833	1,239	594	2,741
English	134	18	70	46	351	57	194	..	..	..	100	..	..	..	485
Book-keeping	2,265	101	1,140	1,024	4,287	403	2,485	..	..	..	1,399	4,601	2,915	1,686	11,153
Commercial History and Geography	47	4	19	24	84	7	46	..	..	..	31	..	..	..	131
Commercial Geography	..	..	..	..	...	..	..	..	..	..	..	401	224	177	401
Shorthand	867	94	250	523	4,344	901	2,345	..	..	..	1,098	2,661	1,877	784	7,872
Typewriting	222	56	111	55	887	258	380	..	..	..	249	1,303	857	446	2,412
Economics	55	4	26	25	83	24	45	..	..	..	14	..	..	..	138
Précis-writing	94	30	35	29	268	46	144	..	..	..	78	..	..	..	362
Commercial Correspondence and Business Training	..	..	..	..	303	21	186	..	..	..	96	..	..	..	303
Commercial Law	247	13	122	112	..	..	..	..	..	..	..	..	..	..	247
Accounting and Banking	499	89	274	136	.	..	..	..	..	..	..	..	..	..	499
French	967	153	592	222	1,488	120	1,034	..	..	..	334	1,192	801	391	3,647
German	212	60	84	68	354	85	193	..	..	..	76	428	260	168	994
Italian	25	9	13	3	28	10	13	..	..	..	5	18	14	4	71
Spanish	81	20	32	29	90	24	35	..	..	..	31	107	68	39	278
Portuguese	16	3	9	4	16	1	10	..	..	..	5	..	..	..	32
Russian	4	2	2	..	6	2	2	..	..	..	2	..	..	..	10
Danish and Norwegian	10	2	5	3	5	3	2	..	..	..	..	..	..	..	15
Swedish	7	3	3	1	4	..	1	..	..	..	3	..	..	..	11
Hindustani	2	1	1	..	3	1	1	..	..	..	1	..	..	..	5
Japanese	..	..	..	..	2	..	..	..	..	..	2	..	..	..	2
Handwriting and Correspondence	..	..	..	..	..	..	..	..	..	..	..	1,742	987	755	1,742
Rudiments of Music	..	..	..	..	398	..	..	209	..	128	61	..	..	..	398
Harmony	..	..	..	..	293	..	..	37	69	118	69	..	..	..	293
Totals	5,931	690	2,856	2,385	14,025	2,100	7,469	246	69	246	3,895	14,286	9,242	5,044	34,242

somewhat overdone. Whether all this examination is a good thing or a bad thing, there is no doubt an increasing feeling of dislike to it, and we are now probably at the stage of reaction against over-examination.

There are two points in which examinations have, or may have, a value—first, as a test of knowledge; and, secondly, as an incentive to the acquisition of knowledge. As to their value as a genuine test of knowledge, it is rather difficult to form an opinion. They can only test the information there is in the candidate's head at the moment, and in too many cases that information has acquired but a temporary resting-place there. An examination is, probably, a better test of a candidate's power of acquiring knowledge than it is of the amount he possesses, and perhaps that may be considered as an argument in its favour. As a matter of fact, the question cannot be answered in general terms. Perhaps no better test need be desired of a man's mathematical knowledge than the mathematical tripos at Cambridge. But an elementary examination in physics or chemistry, or indeed in most other subjects, offers but a poor means of estimating the real amount of knowledge possessed by a candidate. But it must always be remembered that on the whole a student who has passed an examination is probably a little better informed and a little better instructed than one who has failed, and if the possession of an elementary certificate does not amount to a great deal, at all events it means something.

As an incentive to the acquisition of knowledge, it is evident that the present system of examination has its value; its enormous extent alone is sufficient to show that. There are very few such earnest students as to be satisfied with the acquisition of knowledge for its own sake, and in the case of most people, especially of young people, an artificial stimulus is required. This stimulus, it is found, can very satisfactorily be provided by hall-marking those who have passed an examination, and allowing them to bear some special title—as "Dr." or the like—or permitting them to attach certain initials to their names.

There is, therefore, a good deal to be said in favour of general examinations, although there is a good deal to be said against them on the score of the superficiality of the knowledge that they tend to produce, and also on account of the very erroneous idea that has been disseminated that the fact of a student having passed an examination is any evidence whatever of his possessing a knowledge of the subject examined in. On the whole, we have got the system firmly established, though perhaps it is rather overgrown and wants pruning. But the important question is to make the system as good and as practically useful as may be.

With regard to the Society's examinations, it has always been a question whether the system adopted of holding separate examinations in separate subjects is the best, or whether it is better to classify the subjects, and only issue certificates on the result of an examination held in a number of specified subjects. The experience of the Society certainly shows that the system of separate examinations is the more popular, and there is much to be said as to its actual merits. The arguments in its favour were very strongly put by Professor Huxley many years ago in an address which he delivered on the occasion of the opening of the Johns Hopkins University at Baltimore. He said: "It (the system of separate subject examinations) allows the student to concentrate his mind upon what he is about for the time being, and then to dismiss it. Those who are occupied in intellectual work will, I think, agree with me that it is important, not so much to know a thing as to have known it, and known it thoroughly. If you have once known a thing in this way, it is easy to renew your knowledge when you have forgotten it; and when you begin to take the subject up again, it slides back upon the familiar grooves with great facility."

It may also be mentioned that the attempts which have been made at different times by the Society to issue a combined certificate have not been very successful, and the demand for the certificate of that sort which is now offered is extremely small.

The examinations this year were held at 459 centres in the week commencing April 3rd, and lasted from the Monday until the following Friday. The results were issued at the following dates:—Advanced Stage, July 6th; Intermediate Stage, August 2nd; Elementary Stage, September 7th. Having regard to the very large numbers of papers to be dealt with, no prospect can be held out of the results being issued at earlier dates.

The Commercial subjects included Book-keeping, Accounting and Banking, Shorthand, Typewriting, Economics, Précis-writing, Commercial Law, Commercial History and Geography, Arithmetic, Handwriting, Commercial Correspondence, etc. (added to the list this year), and Modern Languages. The other subject of examination was Music, divided into Rudiments of Music and Harmony.

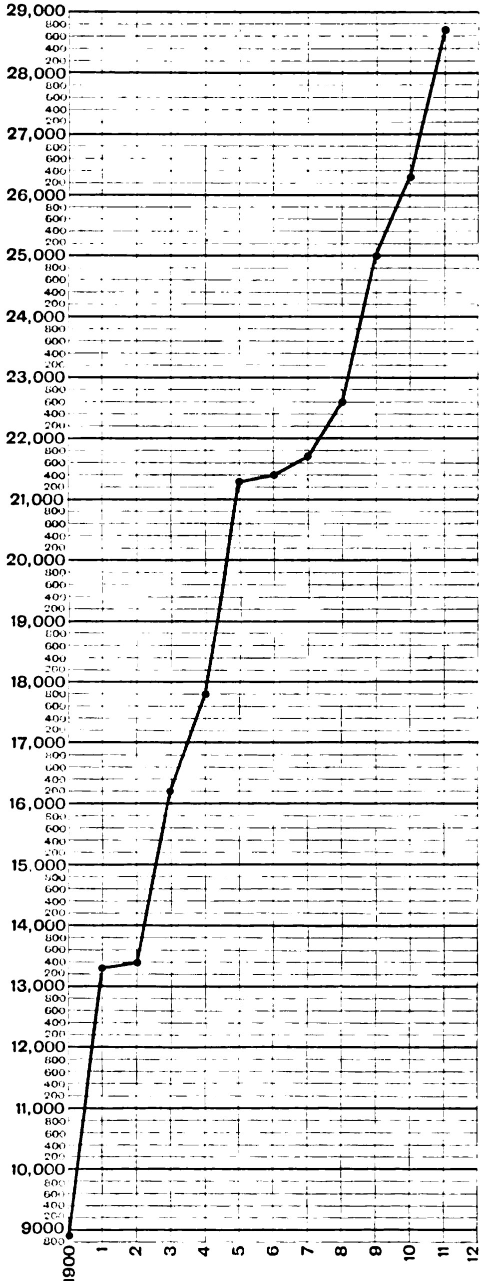
TABLE B.—NUMBER OF PAPERS WORKED IN EACH SUBJECT OF STAGES III. AND II. IN 1906-7-8-9-10-11.

SUBJECTS.	1906.			1907.			1908.			1909.			1910.			1911.		
	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.
Arithmetic	119	512	631	107	446	553	98	544	642	139	653	792	148	638	786	177	731	908
English	52	282	334	60	262	322	60	293	353	74	349	423	91	341	432	134	351	485
Book-keeping	2,088	3,485	5,573	2,082	3,621	5,703	2,054	3,578	5,632	2,158	3,904	6,062	2,049	3,849	5,898	2,265	4,287	6,552
Commercial History and Geography	31	51	82	28	61	89	29	69	98	46	108	154	25	117	142	47	84	131
Shorthand	783	3,486	4,269	854	3,469	4,323	847	3,585	4,432	1,065	3,972	5,037	866	4,464	5,330	867	4,344	5,211
Typewriting	363	780	1,143	254	671	925	270	683	953	252	830	1,082	245	849	1,094	222	887	1,109
Economics	47	59	106	59	30	89	53	52	105	65	73	138	63	68	131	55	83	138
Précis-writing	84	154	238	72	132	204	50	102	152	62	107	169	63	129	192	94	268	362
Commercial Correspondence and Business Training	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	303	303
Commercial Law	224	..	224	238	..	238	214	..	214	216	..	216	237	..	237	247	..	247
Accounting and Banking	322	..	322	302	..	302	288	..	288	369	..	369	407	..	407	499	..	499
French	491	872	1,363	473	1,046	1,519	535	1,144	1,679	655	1,374	2,029	807	1,283	2,090	967	1,488	2,455
German	167	268	435	152	273	425	167	271	438	175	312	487	160	317	477	212	354	566
Italian	16	30	46	21	17	38	21	22	43	21	22	43	28	14	42	25	28	53
Spanish	89	82	171	91	106	197	77	104	181	89	90	179	82	121	203	81	90	171
Portuguese	17	7	24	15	4	19	22	12	34	26	8	34	25	13	38	16	16	32
Russian	5	9	14	3	9	12	2	6	8	4	9	13	2	9	11	4	6	10
Danish and Norwegian	4	5	9	4	8	12	6	3	9	9	..	9	7	4	11	10	5	15
Hindustani	..	..	..	..	..	..	..	1	1	..	..	..	..	..	..	2	3	5
Swedish	2	10	12	..	6	6	2	11	13	8	..	8	4	5	9	7	4	11
Japanese	..	5	5	..	..	..	..	3	3	..	..	..	..	1	1	..	2	2
Chinese	..	..	..	..	..	..	..	..	..	..	2	2	..	2	2	..	..	..
Totals	4,904	10,097	15,001	4,815	10,161	14,976	4,795	10,483	15,278	5,433	11,813	17,246	5,309	12,224	17,533	5,931	13,334	19,265

The Society this year awarded twenty-six Silver and forty-seven Bronze Medals, the former in the Advanced Stage, and the latter in the Intermediate. It also gave away money prizes to the value of £104, besides the prizes, amounting this year to £18—since some were not awarded—provided annually by the liberality of the Clothworkers' Company.

The total number of candidates at the examinations of 1911 was 28,644 (Advanced, 5,134; Intermediate, 12,233; Elementary, 11,277). This is an increase of 2,361 upon the 26,283 candidates of 1910. All the three Stages show larger numbers. In the Advanced Stage there was an increase of 480. In the Intermediate, an increase of 893. In the Elementary an increase of 988. These figures are even more satisfactory than those of last year, when there was a very large growth in the Elementary and a falling off in the Advanced Stage. The number of papers worked by these candidates was: Advanced, 5,931; Intermediate (including Theory of Music), 14,025; Elementary, 14,286, or 34,242 papers in all. In addition to this there were sixty-four Shorthand candidates at the Special Army Examination. In addition to these, again, there were 583 candidates in Colloquial Modern Languages, and 283 in the Practice of Music. The total number of candidates who were examined in all subjects by the Royal Society of Arts during the year ending July last was, therefore, 29,574. The general results of this year's examinations are given in Table A (page 1134), and a comparative view of the numbers examined during the last six years (1906-11) is given in Table B (page 1136). Table K (page 1142) gives the totals of the Commercial and other examinations for the same period, and Table G (page 1138) the numbers of papers worked. The diagram on this page shows the rate of growth from 1900 to 1911.

Considering the total number of papers worked in all Stages (34,242), Book-keeping proves the most popular (11,153); then Shorthand (7,872). None of the other subjects attract anything like these numbers; but French has a large entry—3,647. Of late years there has been a very great increase in the number of candidates taking up French, and this is a very satisfactory sign—the increase being well kept up this year. Arithmetic follows with 2,741; next is Typewriting, with 2,412; Handwriting and Correspondence (Stage I. only), has 1,742. Then there comes German with 994, and Commercial History and Geography 532 (in the Elementary Stage the subject appears as Commercial Geography alone). Accounting and Banking (Stage III. only) has the next largest number with 499. Then comes English with 485. The new subject, Commercial Correspondence and Business Training (in Stage II. only) makes a



good start with 303. The numbers for Spanish were 278, Commercial Law (Stage III. only), 247, Précis-writing 362, a large increase on previous years, and Economics 138. The entries for the other subjects were not very large.

TABLE C.

PERCENTAGES OF SUCCESSES AND FAILURES, ADVANCED STAGE, 1911.

	First-class.	Second-class.	Failures.
Arithmetic	15·82	38·42	45·76
English	13·43	52·24	34·33
Book-keeping	4·46	50·33	45·21
Commercial History and Geography	8·50	40·40	51·10
Shorthand	10·84	28·84	60·32
Typewriting	25·22	50·00	24·78
Economics	7·27	47·27	45·46
Précis-writing	31·89	37·25	30·86
Commercial Law	5·26	49·39	45·35
Accounting and Banking	17·84	54·91	27·25
French	15·82	61·22	22·96
German	28·30	39·60	32·10
Italian	36·00	52·00	12·00
Spanish	24·70	39·50	35·80
Portuguese	18·75	56·25	25·00
Russian	50·00	50·00	0·00
Hindustani	50·00	50·00	0·00
Danish and Norwegian	20·00	50·00	30·00
Swedish	43·00	43·00	14·00

TABLE D.

PERCENTAGES OF SUCCESSES AND FAILURES, INTERMEDIATE STAGE, 1911.

	First-class.	Second-class.	Failures.
Arithmetic	18·74	48·29	32·97
English	16·24	55·27	28·49
Book-keeping	9·40	57·97	32·63
Commercial History and Geography	8·33	54·76	36·91
Shorthand	20·73	54·00	25·27
Typewriting	29·09	42·84	28·07
Economics	28·91	54·22	16·87
Précis-writing	17·16	53·73	29·11
Commercial Correspondence and Business Training	6·93	61·39	31·68
French	8·06	69·49	22·45
German	24·01	54·52	21·47
Italian	35·71	46·43	17·86
Spanish	26·67	38·89	34·44
Portuguese	6·25	62·50	31·25
Russian	33·33	33·33	33·34
Hindustani	33·33	33·33	33·34
Danish and Norwegian	60·00	40·00	0·00
Swedish	0·00	25·00	75·00
Japanese	0·00	0·00	100·00

TABLE E.

PERCENTAGES OF SUCCESSES AND FAILURES IN ALL STAGES, 1906–7–8–9–10–11.

	1906.	1907.	1908.	1909.	1910.	1911.
Advanced (Stage III.).						
First-class	12·86	15·00	12·99	12·60	12·60	11·64
Second-class	49·92	47·80	51·95	44·60	53·38	48·15
Failures	37·22	37·20	35·06	42·80	34·02	40·21
Intermediate (Stage II.).						
First-class	20·77	19·45	22·60	13·31	12·77	15·78
Second-class	47·32	50·25	50·40	53·75	52·47	56·00
Failures	31·91	30·30	27·00	32·94	34·76	28·22
Elementary (Stage I.).						
Passes	59·39	59·62	64·45	66·54	66·80	64·69
Failures	40·61	40·38	35·55	33·46	33·20	35·31

TABLE F.

ELEMENTARY EXAMINATIONS, STAGE I.

Year.	No. of candidates.	No. of papers worked.	No. of subjects.
1901	3,902	4,458	8
1902	4,371	4,807	8
1903	5,382	6,020	8
1904	6,401	7,203	9
1905	7,397	8,427	10
1906	7,425	8,537	10
1907	7,692	8,952	10
1908	8,276	9,811	10
1909	9,196	11,069	10
1910	10,289	12,720	10
1911	11,277	14,286	10

TABLE G.

NUMBER OF PAPERS WORKED IN ALL STAGES, 1905–6–7–8–9–10–11.

	Stage III.	Stage II.	Stage I.	Total.
1905	4,844	10,533	8,427	23,804
1906	4,904	10,734	8,537	24,175
1907	4,815	10,802	8,952	24,569
1908	4,795	11,199	9,811	25,805
1909	5,433	12,512	11,069	29,014
1910	5,309	12,843	12,720	30,872
1911	5,931	14,025	14,286	34,242

The numbers for Stage II. include the papers set in Music.

In the Advanced Stage nearly all the subjects show an increase, in most cases small. In two only the increase is important—French, in which there were 160 more papers than last year, and Book-keeping with an addition of 216. There was an increase of 92 in Accounting and Banking, 10 in Commercial Law, 43 in English, 29 in Arithmetic, 22 in Commercial History and Geography, 52 in German, and 31 in Précis-writing. Shorthand and Spanish are practically the same as last year, there being one more in the former and one less in the latter. The numbers in the other subjects are small, the differences between this and last year's results being negligible.

In this Stage, Book-keeping is by far the most popular subject, the number of papers worked being 2,265. French comes second with 967, then Shorthand with 867. The number of French papers has increased largely of recent years. Last year the subject stood third, Shorthand coming second. Accounting and Banking follows with 499, then Typewriting with 222. The subject of Accounting and Banking was introduced in 1905, and the numbers entering for it have increased regularly year by year. Commercial Law, which was added to the list of subjects in 1905 also, has 247 entries. German has increased, and there were 212 papers worked in it.

In the Intermediate Stage also nearly all the subjects show an increase over the numbers of last year, three only showing a falling off. In Commercial History and Geography there is a deficiency of 33, in Shorthand of 120, and in Spanish of 31. All the other subjects have grown in numbers. Shorthand is the most popular subject in this Stage, with a total of 4,344. Book-keeping with an increase of 438, and a total of 4,287, is very close, and will probably take the lead another year. The third largest subject is French with 1,488 entries, 205 above last year. Typewriting comes next with 887, and a small increase of 38. In Arithmetic there were 731 and a large proportional increase of 93. In German there were 354, only 37 more than in 1910. The numbers in English were nearly the same, 351, 10 more than last year. The new subject —Commercial Correspondence and Business Training—attracted 303 candidates, which was very good for a beginning. The candidates for Précis-writing were twice as numerous as in the previous year, 268, with an increase of 139. It is unsatisfactory that there should be so considerable a proportionate diminution in number of candidates in Spanish, there having been only 90 as compared with 121 in 1910. Though the number in Italian is not very large, 28, it is just double what it was last year. For Economics there was a small increase of 15. In Portuguese 3 more were examined than last year. There were a few candidates in Russian, Hindustani, Danish and Norwegian, Swedish and Japanese—none in Chinese.

In the Elementary Stage the 11,277 candidates worked 14,286 papers, so that, as is always the case, a large proportion of the candidates in this as in the higher stages, were content with a single subject.

The largest number is Book-keeping—4,601, an increase of 785 over last year; then Shorthand 2,661, a decrease of 75; Arithmetic 1,833, an increase of 231; Handwriting and Correspondence 1,742, an increase of 552; Typewriting 1,303, an increase of 172; French 1,192, a decrease of 162; German 428, an increase of 14; and Commercial Geography 401, an increase of 29. The other two subjects are Spanish 107, an increase of 27, and Italian 18, a decrease of 7.

In all, 9,242 certificates were granted to successful candidates, and there were 5,044 failures. The percentage of success (64·69) is not quite so good as last year (66·80), or the year before (66·54), and this is to be regretted. It rose steadily from 59·39 in 1906, and it is difficult to understand why the improvement should have ceased. Figures relating to the Elementary Stage for the past eleven years are given in Table F (page 1138), and the percentages of successes and failures for the last six in Table E (page 1138).

The number of centres at which the examinations are held has increased with the growth of the examinations, and during the last seven years in rather larger proportion than the number of candidates. In 1905 there were 383 centres. This year there are 459. Of these, 346 were in England and Wales, 48 in Scotland, 64 in Ireland, and one in the Channel Islands (Guernsey).

The different subjects in the two higher Stages may now be considered a little more in detail. The percentages of success and failures in each subject in the two higher Stages are set out in Tables C and D (page 1138), and the general percentages for the last six years in Table E (page 1138), Table H (page 1140), and Table I (page 1140).

In Arithmetic there is a satisfactory increase in the number of entries, both in the Advanced

Table H.

Percentages of Failures in all Subjects, Advanced Stage, 1906–7–8–9–10–11.

	1906.	1907.	1908.	1909.	1910.	1911.
Arithmetic	33·62	25·23	33·67	47·48	44·00	45·76
English	36·50	40·00	41·50	37·10	34·07	34·33
Book-keeping	36·10	32·04	33·93	41·43	36·40	45·21
Commercial History and Geography	48·40	32·14	37·93	50·06	44·00	51·10
Shorthand	52·69	62·18	45·70	73·90	38·11	60·32
Typewriting	33·61	31·10	23·70	29·76	59·59	24·78
Economics	25·53	30·51	32·07	24·62	31·75	45·46
Précis-writing	40·48	41·67	28·00	30·60	26·98	30·86
Commercial Law . . .	37·06	30·45	43·00	33·80	39·24	45·35
Accounting and Banking .	31·06	32·12	30·21	30·08	25·80	27·25
French	30·55	30·45	31·96	24·74	19·44	22·96
German	28·70	27·00	34·73	26·29	23·75	32·10
Italian	18·75	14·40	14·28	14·24	14·28	12·00
Spanish	34·83	35·15	27·27	29·00	45·12	35·80
Portuguese	11·70	0·00	0·00	0·00	16·00	25·00
Russian	0·00	0·00	0·00	0·00	0·00	0·00
Hindustani	..	..	..	..	..	0·00
Danish and Norwegian .	0·00	25·00	16·66	11·00	14·28	30·00
Swedish	0·00	..	0·00	12·50	0·00	14·00

Table I.

Percentages of Failures in all Subjects, Intermediate Stage, 1906–7–8–9–10–11.

	1906.	1907.	1908.	1909.	1910.	1911.
Arithmetic	37·89	34·50	34·38	35·38	31·98	32·97
English	26·25	36·30	37·54	31·23	28·17	28·49
Book-keeping	24·71	27·34	23·31	30·74	30·76	32·63
Commercial History and Geography	35·20	50·80	33·33	33·30	29·06	36·91
Shorthand	38·52	27·70	26·15	36·64	43·06	25·27
Typewriting	31·92	31·59	22·26	31·59	32·27	28·07
Economics	32·20	26·67	30·77	27·40	19·12	16·87
Précis-writing	35·07	43·94	33·33	31·78	27·91	29·11
Commercial Correspondence and Business Training .	..	..	..	..	..	31·68
French	32·33	29·64	20·00	29·33	26·58	22·45
German	34·33	35·53	35·00	46·15	32·49	21·47
Italian	20·00	23·55	13·00	18·00	14·29	17·86
Spanish	18·29	35·84	27·90	26·66	23·97	34·44
Portuguese	38·57	0·00	0·00	0·00	30·77	31·25
Russian	33·34	44·45	0·00	33·34	44·44	33·34
Danish and Norwegian .	20·00	0·00	9·09	..	0·00	0·00
Swedish	60·00	83·33	0·00	..	20·00	75·00
Japanese	100·00	..	33·34	..	100·00	100·00
Hindustani	..	..	0·00	..	..	33·34
Chinese	..	..	..	0·00	0·00	..

and Intermediate Stages; but though the percentage of failures is lower in Stage II. it is higher in Stage III. This fact corresponds with the remark of the examiner that the number of first class candidates has not increased in quite the same proportion, and that some of the candidates would have been better advised to defer taking this paper until they were more fully prepared. Still there was a considerable amount of sound and intelligent work, including some really excellent papers. Of the entries in the lower grade he also remarks that a great many are not nearly up to the standard of the grade.

In English also there was a considerable increase in the number of papers, and, as far as can be judged from percentages, the standard of the papers is much about the same as last year. The general results of the examination are reported as encouraging. A satisfactory feature in Stage II. is that a larger percentage of the candidates obtained first-class certificates.

In Book-keeping there is in both Stages a considerable increase; but this increase in numbers is not accompanied by a corresponding increase in quality. In both Stages the results are distinctly less good than last year or the years preceding.

In Commercial History and Geography the numbers examined show an increase in Stage III. and a decrease in Stage II. Although the percentage of failures was higher in both Stages, the examiner speaks well of the work. Though he does not find in Stage III. a corresponding rise in the quality of the work done, he thinks that in Stage II. there was a very marked improvement in the general character and standard of the work.

In Shorthand the number of candidates in Stage III. was practically identical with last year. In Stage II. there was a trifling falling off. In the Advanced Stage there is a decided advance in the first class, but a drop in the second class, and an increase in the proportion of failures. The diminution in the second class is to be accounted for by the alteration in the rules. Up to the present year a candidate failing in the first class paper might, at the discretion of the examiner, be awarded a second-class certificate. But on the whole this plan did not appear to give satisfaction, and it was altered in the examinations last held. In spite of this alteration, however, the numbers both of first and second class papers in Stage II. show an increase, and there is a proportionate decrease in the number of failures. The quality of the work in this Stage has, in the examiner's opinion, shown a decided improvement.

In Typewriting there were a few less papers worked in Stage III. and a few more in Stage II. The percentage calculations show an improvement in both Stages, and this agrees with the comments of the examiner, who finds a gratifying improvement of recent years both in the quality and the quantity of the work submitted.

In Economics there is a smaller entry in Stage III., but a larger one in Stage II. The examiner expresses regret that in the Advanced Stage the quality of the work shows a falling off as compared with last year; but, on the other hand, in the Intermediate Stage, the work as a whole has improved since last year. This opinion is confirmed by the percentage of failures, which is greater in Stage III. and less in Stage II. The conclusion to be drawn from this fact is that a number of candidates as usual make the mistake of entering for the Advanced Stage who are only capable of dealing with the Intermediate paper.

In Précis-writing there was a small increase in the Advanced Stage, and a very large increase in the Intermediate. In the opinion of the examiner the work in Stage III. was quite up to the average of recent years. In Stage II. the proportion of first class candidates was unduly small.

In Commercial Law there is again a slight but satisfactory increase in the number of candidates, but only a small proportion of papers were good enough to reach the first class standard, and the percentage of failures was larger than usual. The best papers sent in this year were not quite up to the rather high standard which has been maintained by the medallists in previous years.

In Accounting and Banking there was a large addition to the numbers of last year. There has been a steady and continuous increase since the examination was established, and the number has nearly doubled itself since 1908. The percentage of first class is higher than in any previous year. Although the percentage of passes is rather lower than last year, the average of work on the whole compares favourably with that of previous years.

The increase in the number of candidates for the French examination is one of the most remarkable features in the statistics of the examinations of recent years. In Stage III. the percentage of failures is higher, but it is lower in Stage II. On the whole, the examination in both classes has given satisafctory results, and

TABLE K.

CANDIDATES EXAMINED IN 1906-7-8-9-10-11.

	1906.	1907.	1908.	1909.	1910.	1911.
Commercial Knowledge—						
Stage III.—Advanced	4,362	4,279	4,283	4,770	4,654	5,134
Stage II.—Intermediate (including Theory of Music) . . .	9,572	9,752	10,038	11,076	11,340	12,233
Stage I.—Elementary	7,425	7,692	8,276	9,196	10,289	11,277
Totals	21,359	21,723	22,597	25,042	26,283	28,644
Music (Practice)	467	457	432	392	339	283
Colloquial Modern Languages . .	644	629	615	656	642	583
Army Candidates	..	40	89	65	66	64
Totals in all Subjects . .	22,470	22,849	23,733	26,155	27,330	29,574

TABLE L.

VIVA VOCE EXAMINATIONS HELD DURING 1910-11.

Place of Examination.	Date.	Number of Candidates.	Passed with Distinction.	Passed.	Failed.
French :—	1910.				
Guernsey Education Committee	Nov. 17 .	32	5	24	3
	1911.				
Acton and Chiswick Polytechnic	March 22 .	19	4	9	6
Liverpool School of Commerce	April 26, 27	41	2	30	9
Manchester Education Committee	May 15 .	13	4	7	2
Enfield Technical Institute	May 29 .	20	4	13	3
Kensington College	June 1 . .	26	7	13	6
Birkbeck College	June 9 . .	28	6	15	7
City of London College (Candidates from London Polytechnics)	June 12 .	28	7	18	3
Birkbeck College (Candidates from London Polytechnics) . .	June 14 .	29	6	17	6
Pitman's School (Candidates from London Polytechnics) . .	June 16 .	31	19	7	5
Merchant Venturers' Technical College, Bristol	June 20 .	28	3	16	9
"Barnsbury Park" L.C.C. School	June 28, 30	40	17	22	1
L.C.C. Evening School, Sussex Road, Brixton	July 3 . .	17	7	8	2
L.C.C. Evening School, Plough Road, Clapham Junction . .	July 4 . .	18	2	10	6
L.C.C. Evening School, Choumert Road, Peckham	July 5, 7 .	40	15	19	6
L.C.C. School of Arts and Crafts	July 10 .	16	10	4	2
German :—					
Manchester Education Committee	May 16 .	10	2	6	2
Pitman's School (Candidates from London Polytechnics) . .	June 8 . .	26	12	9	5
City of London College (Candidates from London Polytechnics)	June 13	29	7	13	9
Merchant Venturers' Technical College, Bristol	June 19 .	25	1	13	11
L.C.C. School of Arts and Crafts	July 11 .	20	4	13	3
Spanish :—					
Manchester Education Committee	May 18 .	8	2	3	3
Birmingham Education Committee	May 27 .	14	1	7	6
City of London College (Candidates from London Polytechnics)	June 15 .	15	2	9	4
Italian :—					
Birkbeck College (Candidates from London Polytechnics) . .	June 19 .	10	2	7	1
Total		583	151	312	120

the general standard appears to have been maintained.

It is a little remarkable that while in other quarters there are complaints of want of attention being paid in this country to the study of German, the numbers entering for the Society's examinations in that subject by no means confirm such a view, as there is an increase in both Stages; and the examiner reports that it is evident that an increasing number of students are reading German with intelligence and profit. The improvement noted last year has been well maintained.

The examiner in Italian speaks well of the work submitted in both Stages.

The examiner in Spanish considers the work in Stage III. satisfactory as regards the majority of the candidates, though a good many had not the least right to attempt such a high standard. On the other hand, the work of the candidates in Stage II. was well up to the standard required.

In Portuguese there is no sign of improvement, rather the contrary. The numbers show a slight decrease, and the standard is distinctly lower.

With regard to the other language examinations there is not a great deal to be said. The numbers are much too small for any general conclusions to be drawn from the results. Where so few candidates enter it has generally been considered desirable to keep the standard down, with a view of encouraging students to enter; but in some cases the utmost leniency has not sufficed to justify the passing of some of the candidates.

With reference to the new subject added this year to the Intermediate Stage—Commercial Correspondence and Business Training—both the number of entries and the results may be regarded as quite satisfactory. It was thought well that for the first year considerable leniency should be shown, and the standard was kept as low as was consistent with justice. After a few years it will certainly be expected that to obtain a first-class certificate candidates will have to display a higher standard of knowledge.

For the Viva Voce Examinations held this year in Modern Languages 583 candidates entered—a decrease on last year, when there were 642. These examinations were started in 1902, when 280 candidates were examined. The numbers rose to 681 in 1905, after that there was a slight falling off. Examinations were held this year in French, German, Spanish, and Italian; there have also in previous years been a few entries for Portuguese, but none entered during the last three years. The numbers were: French, 426; German, 110; Spanish, 37; Italian, 10. Table L (page 1142) gives in detail the results of this year's examinations.

The examiner in colloquial French reports that the examination was in no way below the level of its predecessors. The German examiner again says that though the number of candidates examined was smaller than in 1910, the percentage of successes was higher, and considers that the general results were extremely satisfactory. The results in Spanish are still rather unsatisfactory, though a little better than last year; the numbers entering were a little larger, and the proportion of failures was smaller. Though the numbers entering in Italian is never very large, the candidates appear to be better taught, and the proportion of failures is always very small.

The examinations in Rudiments of Music and Harmony were carried on as usual at the same time as the Commercial examinations, and the results appeared as part of the results of the Intermediate Stage. The total number of candidates shows an increase as compared with last year. This year there were 691, compared with 619 in 1910, 699 in 1909, 716 in 1908, 641 in 1907, and 637 in 1906. In Rudiments of Music, 398 candidates presented themselves, whereas last year there were 377. In Harmony there were 293, as compared with 242. Of the 398 candidates in Rudiments of Music, 337 passed and 61 failed. Of the candidates in Harmony, 224 passed and 69 failed. The examiner, on the whole, reports favourably on the results, which do not differ very much from those of recent years.

A report on the Practical Examinations in Music has been published in the *Journal*.* 283 candidates were examined—a decrease of 56 as compared with the 339 last year; of these 214 passed and 69 failed. These examinations have been carried on continuously since they were established in 1879. The numbers for a long time did not vary very widely. In the first year 117 candidates were examined. The numbers increased gradually to 276 in 1891, and to 393 in 1895. The largest number yet examined was 566 in 1900. During the last few years there has been a small but steady diminution in the numbers. The standard has not varied much, but is now a little higher than it was. The general level of attainment is considered by the examiners to be about the same as for the last few years.

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* See *Journal*, July 21st, 1911, Vol. LIX. p. 869.

At the request of the Army Council, the Council, in 1907, arranged to hold a special annual examination in Shorthand for soldiers, and such an examination has been held every year since. In 1907 there were 40 candidates; in 1908, 84; in 1909, 60; in 1910, 66. This year there were 64 entries. There were 26 centres in the United Kingdom, India, South Africa, and Egypt. These examinations were held on March 30th. Of the 64 candidates, 47 passed and 17 failed. In the Advanced Stage there were 7 second class, but no first. In the Intermediate Stage there were 15 first and 25 second. The percentage of successes is a little over 73, which is not as good as last year, which was 82. Still this is much above the average of Shorthand examinations.

The Examination Programme for 1912 was issued three weeks ago. In it will be found the fullest possible information about the Examinations, a syllabus of each Stage of each subject, and the papers set in 1911. The attention of both teachers and students may be drawn not only to the syllabuses but also to the remarks of the various examiners on the results of last year. It will be found that these contain many valuable and helpful suggestions, and the work of the candidates year after year shows that far too little attention is paid to them. Teachers especially should study these remarks, and be guided by them in the instruction they give to their pupils. The remarks of each examiner follow his examination paper in the Programme for each year.*

The regulations for the Examinations in Music (Theory and Practice), and those for the Viva Voce Examinations in Modern Languages, are also given at full length.

COTTON-GROWING IN ERITREA.

As one of the aims of the Italian Government in the development of their African colony of Eritrea is the keen desire to give to the cotton industry, at present largely dependent on American cotton, a new, and what might be called "home" supply of the raw material, much importance is attached to the proposal to cultivate cotton on a large scale in Eritrea. Investigations have proved that about 90,000 acres can at present be utilised for such cultivation without any special preparation of the soil, and an additional 125,000 acres if advantage be taken of the natural inundations. With the construction of the hydraulic works, already studied and planned out, for the irrigation of the plains of Tessenei and the valley of the Barca, a much larger area can eventually be adapted for the growing of cotton. It is estimated that the two areas are capable of producing 264,000,000 pounds of cotton annually. A Milan concern, which holds a concession for the cultivation of cotton in Eritrea, has already two ginning plants in the colony—one at Agordat, and a less important one at Massowah. From about 2,300 acres conceded to this company, a production of 2,200,000 pounds was expected in 1911. This is not a notable quantity, but the small production is due largely to the cost of transportation. This is the most important question in the economic development of the colony, and the Italian Government proposes to extend the present railway line from Massowah to Asmara (now nearly completed) as far as Keren, a farther distance of about sixty miles. With this line in operation, the products of the valley of the Barca will be brought by rail to the port of Massowah in five days, instead of the eighteen days by camel as at present. The Ministerial project meets with general favour, and it is believed that the extension will be built, and in operation, within the next two years.

THE USE OF ELECTRICITY IN NEW ZEALAND.

The demand for electricity in New Zealand for industrial purposes, such as for factories, mining, tramways, street lighting, and for domestic lighting, heating, and cooking, is increasing constantly. The public has become so educated to electricity, that the need for its cheap development by water power is well recognised by local government authorities, who now feel that unless they are prepared to permit private capital to establish water-power works, they can no longer refrain from committing themselves to the necessary expenditure and risks. At present, according to the American Consul on special service in New Zealand, 1,320,000 units of electricity are sold annually for electric lighting in Wellington, 742,000 in Dunedin, and 369,620 units in Christchurch. In Auckland electric lighting has just been introduced. In all these cities, except Dunedin, electricity is now produced from coal. Electric street lighting is already fairly well developed in Wellington and Dunedin, 562,000 units being used last year in Wellington, and 102,000 units in Dunedin. In Auckland one road has been successfully lighted with flame arc lamps, and no doubt the system will be extended to all the main thoroughfares. In Christchurch street lighting by electricity has not yet been attempted, except for a few arc lamps maintained at the tramway stopping places. The Minister of Public Works estimates that within the next five years, owing to the introduction of

* The price of the Programme (136 pages) is 3*d*., post free 4½*d*. Copies can be obtained on application to the Secretary of the Royal Society of Arts, Adelphi, London, W.C. Programmes containing the papers set in 1905, 6, 7, 8, 9, 10 can also be obtained at the same price. The regulations and syllabuses can also be had separately (without the papers) price 1*d*., by post 1½*d*

cheap electric power, Wellington will have 190 miles of streets lighted with 220 electric arcs and 2,000 electric glow lamps; Auckland, 150 miles lighted with 200 electric arcs and 500 electric glow lamps; Christchurch, 170 miles lighted with 220 electric arcs and 400 electric glow lamps; and Dunedin, 180 miles lighted with 240 electric arcs and 600 electric glow lamps. It is stated, on the same authority, that the demand for electricity as a domestic utility will probably be as great as for electric lighting. It is estimated that within five years' time there will be 4,200 electric stoves and heaters used in Wellington, 3,200 in Auckland, 3,100 in Christchurch, and 3,200 in Dunedin. Among the electro-chemical industries suggested for New Zealand in connection with its water power is the manufacture of calcium carbide, the imports of which are increasing each year. Probably of still greater importance to New Zealand is the possibility of electric smelting of iron and steel, as the country is fortunate in having iron deposits, and the necessary limestone flux within easy distance of extensive water power.

HOME INDUSTRIES.

The Crops.—The preliminary statement showing the estimated total produce and yield of crops in 1911 has just been issued by the Board of Agriculture and Fisheries, and shows that the wheat crop of 1911, amounting to 7,832,196 quarters, is the largest returned since 1899, and exceeds by nearly one million quarters the crop of last year. The yield per acre was one and one-seventh bushels (3·6 per cent.) above the average of the preceding ten years, and two and a half bushels more than in 1910, though smaller than in 1909 by nearly one bushel per acre. Each of the other crops is more or less below average. The yield of barley was one and a half bushels per acre below average, and the total crop is more than a million quarters less than the average, and smaller than in any previous year on record. Oats were over two bushels per acre short of an average, and the total crop is less than in any year since 1901. Beans were five bushels per acre below average, and, notwithstanding a substantially increased acreage, gave a total crop of 120,000 quarters less than in 1910. The yield of peas was slightly better than in 1910, but nearly a bushel per acre below average. Clover and "seeds" hay yielded 5 cwts. per acre, or 16 per cent., below average, while meadow hay gave little more than three-fourths of an average. The total crop of clover and "seeds" hay is the smallest since 1893, and of meadow hay the smallest since 1901. Altogether, the hay crop of 1911, amounting to 7,183,240 tons, is 2,333,000 tons less than that of 1910, and about 20 per cent. below the ten years' average.

The Cotton Crop.—Messrs. Hubbard Bros. & Co., who are amongst the most careful of American commentators on the affairs of the cotton market, support by anticipation Messrs. Neill's estimate of a 15,000,000 bale minimum crop. They write: "It now looks as though the crop would exceed 15,000,000 bales, and no one knows what such a crop is worth, but that is a chance the speculator must take. The question is—Is he ready to take it now? We do not see that he is, but we note his inquiries." The inquiries referred to here are from those who are waiting a favourable opportunity to buy cotton as an "investment"—that is, with a view to holding it indefinitely for a substantial rise. Messrs. Hubbard think that if trade conditions were better, and the troubles in Tripoli and China were at an end, speculative buying might become a feature of the market. However that may be, the probabilities point to an American cotton crop of unexampled proportions. It may be taken as certain that the crop will be close upon 15,000,000 bales, and may well exceed those figures. The highest previous record was 13,566,000 bales in 1904–5. Low prices would, therefore, seem to be assured, although we may be sure that American manipulators will do what they can in the way of holding back the surplus supply and curtailing next season's acreage to keep up prices. During the past four weeks the quoted decline was fifty-six points, making a difference of 2½*d.* per lb., or 33 per cent. in the price of the raw article as compared with last year. The position of the spinners is in pleasant contrast to what it was in the last two seasons, and though the civil war in China, and threatened coal strikes and railway strikes at home, are adverse counters, it is reasonable to anticipate that the present improvement in the textile trade will be maintained.

The Crown Agents and the Middleman.—It is the practice of the Crown Agents for the Colonies to deal only with actual manufacturers. In this way they eliminate the middleman. An attempt is now being made to induce the Department to vary this practice and to recognise the merchants. It is contended that they are often in a position to offer better terms than the manufacturer. Often they have large stores of the article required, and would supply requirements forthwith. Then they are more familiar with local conditions, and experience has given them a greater aptitude for securing exactness in the work required, than a manufacturer who is concerned with no particular market. Again, the Crown Agent, buying in the colony, or from merchants here who would sell on c.i.f. terms, would know exactly what he was paying, whereas by buying from the manufacturer he is not aware of the exact cost to the colony until he has calculated the cost of packing, insurance, and freights. And yet again, the merchant contends that he is better acquainted than the manufacturer can be with the terms imposed by law as to the make up and marking of goods. The arguments in favour of the merchant being allowed to tender would seem to be weighty.

Rubber Supplies.—It seems likely that the cultivation of Ceara rubber on the Upper Blue Nile will

be carried on successfully, and that a good deal of wild rubber will be got from the Bahr-el-Ghazal province. The Imperial Institute furnished reports during 1910 to the Government of the Sudan on Landolphia and Ceara rubber on the basis of investigations conducted in the scientific and technical department, followed in some instances by submission of samples to manufacturers and experts for technical trial or valuation. The report gives details of two consignments. A small consignment of rubber from the Bahr-el-Ghazal, derived from the indigenous vine, was forwarded for examination and subsequent sale. The rubber was in the form of biscuits and sheet, varying from light to dark brown; it was of good quality and contained from 92·7 to 93·6 per cent. caoutchouc in the dry material. The consignment, weighing 647 lbs., was divided into four lots and sold in London at prices ranging from 6*s.* 9*d.* to 8*s.* 4*d.* per lb. Brokers reported that the rubber was exceptionally strong, and that prepared with a little more care it should realise prices comparing favourably with those of Eastern plantation rubbers. A sample of Ceara rubber, derived from two-year-old trees at Mongalla, consisted of clean biscuits of pale yellow rubber which exhibited good physical properties. Great care had been used in the preparation. It was not quite as good in composition as specimens of Ceara rubber from Ceylon, but it was superior to several samples from East Africa which have undergone examination at the Imperial Institute.

The Insurance Bill.—It may be taken as certain that the Insurance Bill will become law before the end of the year, unless the House of Lords rejects it. The Ministerial majority is unshaken, and, with the closure, will enable Ministers to carry the measure. Some of its more glaring anomalies have been removed or lessened, but it is to be feared that in its final form it will be very faulty. Perhaps that was inevitable, having regard to the conflicting and varied interests with which it deals, but more prolonged discussion than it will receive was necessary to make the measure one that might be regarded without deep anxiety as to its effect when in operation. For example, an amendment was moved, the intention of which was to prevent approved societies selecting certain cases for insurance and rejecting others at will. Mr. George opposed it. In doing so he said that the societies would depend for their success upon good management, which is true enough; but he went on to say that such good management would be shown not in a careful selection of good, healthy, insurable persons, but in the rigorous examination of claims for sick benefit, and that even a doctor's certificate to the effect that the applicant was sick must not be accepted as *prima facie* evidence that the sickness was *bona fide*. The reader interested in the matter should refer to the official parliamentary report for Mr. George's exact words; the above is their purport. But they will not bear examination. The Bill makes the society responsible for excessive sickness, and excessive sickness means one of two things, either an additional levy or reduced benefits. But the first factor in producing a sickness claim not in excess of the actuaries' expectation, is the careful scrutiny and selection of new entrants. And any society which refuses to pay sickness benefit upon the medical certificate of qualification for it will act unlawfully. In such a case the medical evidence must be absolute, but Mr. George thinks otherwise. In his opinion the evidence must be judged "ruthlessly." You are to accept the workman's proposal and his money, in return for which you give him a contract to pay certain benefits, and then you are to set up a standard of your own by which to decide whether the benefits shall be paid or not.

Canadian Immigration.—During the last ten years Canada has received nearly 2,000,000 immigrants, of whom approximately 750,000 were from the United Kingdom and 700,000 from the United States. Up to the close of the fiscal year ended March 31st, 1911, the total was 1,714,326 for the decade. Since then nearly 200,000 more have arrived, divided about equally between British and American immigrants. About 65 per cent. of the immigrants arriving from the United States have been farmers, who for the most part, have settled in the prairie provinces. Thirty-eight per cent. of the total number from the United States made entries for homesteads in the west. About 30 per cent. of the European arrivals were farmers or farm labourers, according to the American Consul at Kingston, while 25 per cent. were classed as general labourers, and nearly the same percentage as mechanics. The influx of negroes has totalled a little over 400, while 5,200 Hindus have come to Canada. Of the British immigrants, approximately 500,000 have been English and Welsh, 150,000 Scotch, and about 45,000 Irish. Figures for other nationalities include, Austro-Hungarian 121,000, Italian 63,817, Russian 39,950, Swedish 19,349, German 21,146, French 16,236, Norwegian 13,798, Syrian 5,223. Western Canada received some 300,000 more immigrants than the eastern section. Saskatchewan and Alberta received more than half a million.

NOTES ON BOOKS.

LONDON HOUSES FROM 1660 TO 1820. A consideration of their architecture and detail. By A. E. Richardson and C. Lovett Gill. London: B. T. Batsford. 15*s.* net.

Although so many illustrated books about London have been published of late, Messrs. Richardson and Gill have found fresh ground to cultivate in the representation of the dwelling-houses situated in the old streets and squares, and they have

exhibited beauties likely to be overlooked by the casual passer-by. This, however, is not merely a book of pictures, as the examples are chosen in accordance with a systematic plan by which the years covered by the title are divided into three periods—(1) The Formative period, 1666-1720; (2) Middle or Palladian, 1720-1760; (3) Refined or Formal Classic, 1760-1820. The reason why these houses are so well worthy of notice is that they were produced by the chief architects of their times, such as Wren, Isaac Ware, Taylor, Chambers, the brothers Adam, Bonomi, Leverton, Soane, Nash, and Decimus Burton.

The West-End squares are amongst the chief glories of London, and the houses are here safer from interference than those in business quarters, but a very fine specimen of Adam's work—Harewood House, Hanover Square—has lately been destroyed to make room for the erection of a huge building. Two of the handsomest houses in St. James's Square—Lichfield House (No. 15), designed by "Athenian" Stuart, and Sir Watkin Wynne's house (No. 20) by Robert Adam—are both illustrated in this book. No. 15 has always been recognised for its beauty, whilst No. 20 was generally overlooked until the revival of interest in Adam's work. The latter is unpretentious, but its originality and charm are so considerable that possibly those who examine it carefully will prefer it to Stuart's more noted work.

Three of the plates are devoted to the Adelphi, and show an excellent doorway in John Street and the front of Alliance House in Adam Street, with an enlarged view of the lace-like balconies. The authors have produced a charming series of drawings of fanlights and balconies. The senseless destruction of some of these things in the nineteenth century is amazing. In Russell Square may be seen a house with a fanlight of one sheet of plate glass, and next door a beautifully designed fanlight like unto those figured by the authors. What must have been the standard of taste of those who replaced such a work of art by a plain piece of glass? The illustrations to this book, exhibiting the manifold beauties of many apparently commonplace houses will surprise even those who know London streets well, for they are shown designs which are well worth a pilgrimage to see.

H. B. Wheatley.

GENERAL NOTES.

The Swiss Hotel Industry.—The number of tourists who frequent the Swiss hotels ranges from 400,000 to 500,000 a year on an average, about 30 per cent. of whom are Germans, 20 per cent. Swiss, 15 per cent. English, 12 per cent. French, 6 per cent. Americans, 4 per cent. Russians, and 2 per cent. Belgians. These travellers, according to the Belgian Minister at Berne, expend on an average about ten shillings a day. During at least two months, beginning with the middle of December, the hotels of St. Moritz, Davos, Grindelwald, Adelboden, and Montreux are filled. Château d'Oex, Engelberg, Andermatt, and other parts, all have a winter season, as do also localities in the Jura mountains of Vaud. The influx of foreigners to the shores of Lake Geneva is explained by reasons of climate and the world-wide reputation of specialists who reside there, principally at Lausanne. The winter *clientèle* is composed chiefly of English and Germans. During the winter of 1909-10 English patrons formed 48 per cent., Germans 22 per cent., Swiss 14 per cent., French 6 per cent., Belgians and Dutch 3 per cent., Americans 3 per cent., Russians 1 per cent. Much money has been spent in the course of the last few years in the construction of new, and the enlargement of old, hotels, but there are no statistics in this regard later than for the year 1905. Statistics for that year show that the total capital engaged in the Swiss hotel industry was about £31,000,000.

Royal Sanitary Institute Congress, 1912.—The Royal Sanitary Institute have accepted an invitation from the City Council of York to hold their Twenty-seventh Congress and Exhibition in that city from July 29th to August 3rd, 1912.

Non-Ferrous Metals Exhibition.—An international exhibition of non-ferrous metals will be held at the Agricultural Hall, Islington, from May 6th to 18th, 1912, under the presidency of Sir Gerard Alfred Muntz, Bart., President of the Institute of Metals. This is the first exhibition entirely devoted to the display of non-ferrous metals, their alloys, the apparatus used in their manufacture, and their applications to commercial, scientific, and domestic purposes.

The World's Output of Coal, 1909.—According to the report recently issued by the Chief Inspector of Mines, the number of persons engaged in mining and quarrying throughout the world in 1909 was considerably over six millions. Of this total nearly one-fifth were employed in the United Kingdom and more than one third in the British Empire. More than half were employed in getting coal alone, Great Britain employing over 997,000, the United States 666,000, Germany 688,000, France 190,000, Russia 174,000, Belgium 143,000, Austria nearly 134,000, and India over 119,000. The world's total output of coal was 1,113,000,000 tons, the value of which is estimated at nearly £400,000,000. As compared with 1908, these figures show an increase of 45,000,000 tons in the output, but a decrease af £9,500,000 in the value.

The Banana Industry of Santiago de Cuba.—The production of bananas is second in importance among the agricultural industries of Santiago de Cuba. There are three districts where bananas are grown for export. Saetia, on Nipe Bay; Sagua de Tanamo, on Tanamo Bay, and in the region about

Baracoa. The plantings at Saetia and Sagua de Tanamo are on lowland along the valleys of the Yumuri and Tanamo Rivers. The soil is a deep loam, formed from the deposits of the rivers and streams flowing from the Mayari mountains on the south and from decomposed vegetation. At Baracoa, the plantings are in the valleys and on the mountain slopes. The soil is also a deep loam from a disintegration of the rocks and earlier vegetation. There has been a large decrease in banana growing for export during the last decade. Large areas devoted to that industry have been planted in sugar-cane, because greater returns are derived from land planted with cane, and because the fruit produced in Cuba cannot compete with that of the Central American States, the winters of Cuba being too cold and dry. All the bananas produced for export are sent to the United States.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOVEMBER 13...East India Association, Caxton Hall, Westminster, S.W., 4.30 p.m. Sir Roland K. Wilson, "Compulsory Education for India in the Light of Western Experience."

Sanitary Engineers, Caxton Hall, Westminster, S.W., 8 p.m. Sergeant Dunworth, "Camp Sanitation: My Experiences during the Annual Training, 1911."

Brewing, Institute of (London Section), Criterion Restaurant, Piccadilly, W., 8 p.m. Mr. L. Chew, "Mechanical Refrigeration and its Application to the Brewing Industry."

Post Office Electrical Engineers, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 6 p.m. Mr. W. S. Mountain, "Departmental Contracts."

Surveyors, 12, Great George-street, S.W., 8 p.m. Opening Address by the President, Mr. W. Edgar Horne, M.P.

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. (Graduates' Section.) Mr. James Brander, "Modern Locomotives."

London School of Economics, Clare-market, W.C., 5 p.m. Dr. C. S. Loch, "State Insurance."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. S. L. Hughes, "Oddities in Parliament."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. T. B. Fulton, "That the True Hope of Architecture lies in the Study of Good Modern Work."

TUESDAY, NOVEMBER 14...Sociological, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Rev. Principal Garvie, "Contemporary Social Developments of Canada."

Asiatic, 22, Albemarle-street, W., 4 p.m. Sir Charles J. Lyall, "The Pictorial Aspects of Ancient Arabian Poetry."

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Mr. A. H. Roberts, "The Loch Leven Water-Power Works." 2. Mr. F. B. Sonnenschein, "The Hydro-Electric Plant in the British Aluminium Company's Factory at Kinlochleven."

Photographic, 35, Russell-square, W.C., 8 p.m. (Traill Taylor Memorial Lecture.) Dr. W. Rosenhain, "Optical Glass."

Anthropological, 50, Great Russell-street, W.C., 8.15 p.m. Mr. R. W. Williamson, "The Mafulu Mountain People of British New Guinea."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. Dr. G. R. Parkin, "True Imperialism."

WEDNESDAY, NOVEMBER 15...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Opening Address of the 158th Session by Lord Sanderson, G.C.B., Vice-President and Chairman of Council.

Meteorological, 25, Great George-street, S.W., 7.30 p.m. 1. Mr. C. Harding, "The Abnormal Summer of 1911." 2. Mr. W. Larden, "Notes on Solar Halos."

Incorporated Accountants (Students' Society), 50, Gresham-street, E.C., 6.30 p.m. Mr. C. T. Tunstall, "Some Points as to Deeds and other Instruments."

Auctioneers (Junior Members), 34, Russell-square, W.C., 7.30 p.m. Mr. E. F. Shepherd, "Conducting a Furniture Sale from Beginning to End."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. J. E. Barnard, "A Geometric Slide Photomicrographic Apparatus." 2. Rev. Hilderic Friend, "British Enchytraeids. II.—The Genus Fridericia." 3. Mr. H. J. Grayson, Slides of Rock Sections.

United Service Institution, Whitehall, S.W., 3 p.m. Captain C. J. Burke, "The Airship as an Aid to the Solution of Existing Strategical Problems."

Mining and Metallurgy, at the Geological Society, Burlington House, W., 8 p.m. 1. Discussion on Mr. Eugene Coste's paper, "Fallacies in the Theory of the Organic Origin of Petroleums." 2. Discussion on Mr. H. S. Ball's paper, "The Economics of Tube-Milling." 3. Mr. H. R. Sleeman, "The Whim Well Copper Mine, West Pilbara, North-West Australia."

THURSDAY, NOVEMBER 16...Linnean, Burlington House, W., 8 p.m. 1. Dr. R. R. Gates, "Recent Researches on Œnothera." 2. Mr. G. C. Druce, "Some Floristic Results of the International Phytogeographical Excursion through the British Isles." 3. Mr. N. O. Macnamara, "Additional Observations on Peloria in the Foxglove."

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. T. S. Patterson and H. H. Montgomerie, "The Influence of Neutral Solvents on Velocity of Reaction. Part I.—Transformation of Anissynaldoxime in Various Solvents." 2. Mr. G. T. Morgan and Miss F. M. G. Micklethwait, "Organic Derivatives of Antimony. Part II.—The Orienting Influence of Antimonic Substituents in the Benzene Nucleus." 3. Mr. A. H. Salway, "Chemical Examination of Calabar Beans." 4. Mr. S. U. Pickering, "Copper Salts and their Behaviour with Alkalis." 5. Messrs. G. G. Henderson and R. Boyd, "Contributions to the Chemistry of the Terpenes. Part XII.—Synthesis of a Menthadiene from Thymol, and of a Dihydrodiethyl Benzene from Phenol."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. H. Beaumont, "Troyes."

Historical, 7, South-square, Gray's Inn, W.C., 5 p.m. Mr. C. K. Webster, "Some Aspects of Castlereagh's Foreign Policy."

China Society, Caxton Hall, Westminster, S.W., 8 p.m. Dr. Chao-chu Wu, "The Longevity of China."

FRIDAY, NOVEMBER 17...Illuminating Engineers, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. 1. Report of Progress during the Vacation, by the Honorary Secretary. 2. Dr. H. R. B. Hickman, "Notes on the Design of Motor-Car Headlights."

Brewing, Institute of (Yorkshire and North-Eastern Section), Queen's Hotel, Leeds, 7.30 p.m. Mr. Harold Wager, "The Dual Nature of the Yeast Plant Nucleus."

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. 1. Discussion on paper by Messrs. E. M. Eden, W. N. Rose, and F. L. Cunningham, "The Endurance of Metals: Experiments on Rotating Beams at University College, London." 2. Mr. J. H. Wicksteed, "Double-Cutting and High-Speed Planing Machines."

CONTRIBUTIONS TO THE READING-ROOM.

The Council have to acknowledge, with thanks to the Proprietors, the receipt of the following Transactions of Societies and other Periodicals.

TRANSACTIONS, ETC.

Aëronautical Society, Journal.
African Society, Journal.
American Academy of Arts and Sciences, Proceedings.
American Chemical Society, Journal.
American Institute of Architects, Bulletin.
American Institute of Electrical Engineers, Transactions.
American Institute of Mining Engineers, Transactions.
American Leather Chemists' Association, Journal.
American Philosophical Society, Proceedings and Transactions.
American Society of Civil Engineers, Transactions.
American Society of Mechanical Engineers, Journal and Transactions.
Architectural Association, Journal.
Association of Engineering Societies (American), Journal.
Australasian Association for the Advancement of Science, Report.
Australian Official Journal of Patents.
Bagnères-de-Bigorre, Société Ramond, Bulletin.
Barrow and District Association of Engineers, Transactions.
Bath and West of England Society, Journal.
British Association for the Advancement of Science, Report.
British Dental Association, Journal.
British Fire Prevention Committee, Publications.
Brussels, Ministère des Colonies, Bulletin de Colonisation comparée.
———, Société d'Etudes Coloniales, Bulletin.
———, Travaux Publics de Belgique, Annales.
Canada, Royal Society, Proceedings and Transactions.
Canadian Institute, Transactions.
Canadian Patent Office, Record.
Canadian Society of Civil Engineers, Transactions.
Chartered Institute of Patent Agents, Transactions.
Chemical Society, Journal.
Chicago, Field Museum of Natural History, Publications.
———, Western Society of Engineers, Journal.
Cleveland Institution of Engineers, Proceedings.
Cold Storage and Ice Association, Proceedings.
East India Association, Journal.
Farmers' Club, Journal.
Franklin Institute, Journal.
Geneva, Société des Arts, La Revue Polytechnique.
Geological Society, Quarterly Journal.
Glasgow, Royal Philosophical Society, Proceedings.
Haarlem, Koloniaal Museum, Bulletin.
Imperial Department of Agriculture for the West Indies, Publications.
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India, Geological Survey, Memoirs and Palæontologia Indica.
——, Government of, "Agricultural Ledger."
Indian Meteorological Department, Monthly Weather Review.
Institute of Bankers, Journal.
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Institution of Civil Engineers, Minutes of Proceedings.
Institution of Civil Engineers of Ireland, Transactions.
Institution of Electrical Engineers, Journal.
Institution of Engineers and Shipbuilders in Scotland, Transactions.
Institution of Gas Engineers, Transactions.
Institution of Mechanical Engineers, Proceedings.
Institution of Mining and Metallurgy, Transactions.
Institution of Naval Architects, Transactions.
International Catalogue of Scientific Literature.
Iron and Steel Institute, Journal.
Japan, College of Science, Imperial University, Journal.
Japan Society, Transactions and Proceedings.
Johannesburg, Chemical, Metallurgical and Mining Society, Journal.
Junior Institution of Engineers, Record of Transactions.
Kew Gardens Bulletin.
Lima, Direccion de Fomento, Boletin.
Linnean Society, Journal.
Lisbon, Sociedade de Geographia, Boletim.
Liverpool, Engineering Society, Transactions.
————, Literary and Philosophical Society, Proceedings.
London Chamber of Commerce, Journal.
Lyons, Société d'Agriculture, Sciences et Industrie, Annales.
Manchester Literary and Philosophical Society, Memoirs and Proceedings.

Manchester, Municipal School of Technology, Journal.
——— Steam Users' Association, Reports.
Milan, Associazione Elettrotecnica Italiana, Atti.
Munich, Königlische Bayerische Akademie der Wissenschaften, Publications.
———, Polytechnischer - Verein, Bayerisches Industrie- und Gewerbeblatt.
National Indian Association, "The Indian Magazine and Review."
National Physical Laboratory, Collected Researches.
National Service League, Journal.
New South Wales, Institute of Architects, Journal.
———, Royal Society, Journal and Proceedings.
New York Academy of Sciences, Annals and Memoirs.
North-East Coast Institution of Engineers and Shipbuilders, Transactions.
Nova Scotian Institute of Science, Transactions.
Paris, Comité International des Poids et Mesures, Procès Verbaux.
——, Conservatoire National des Arts et Métiers, Annales.
——, Société d'Encouragement pour l'Industrie Nationale, Bulletin.
——, Société de Géographie Commerciale, Bulletin.
——, Société des Ingénieurs Civils, Mémoires.
——, Société Internationale des Electriciens, Bulletin.
——, Société Nationale d'Acclimatation de France, Bulletin.
Patent Office, Illustrated Official Journal.
Pennsylvania (Western), Engineers' Society of, Proceedings.
Philadelphia, Academy of Natural Sciences, Proceedings.
———, Engineers' Club, Proceedings.
Physical Society, Proceedings.
Quekett Microscopical Club, Journal.
Royal Agricultural Society, Journal.
Royal Asiatic Society, Journal.
Royal Astronomical Society, Memoirs.
Royal Cornwall Polytechnic Society, Annual Report.
Royal Dublin Society, Proceedings and Transactions.
Royal Horticultural Society, Journal.
Royal Institute of British Architects, Journal.
Royal Institution of Cornwall, Journal.
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Royal Irish Academy, Transactions and Proceedings.
Royal Meteorological Society, Quarterly Journal and Record.
Royal National Life-Boat Institution, "The Life-Boat" and Annual Report.
Royal Sanitary Institute, Journal.
Royal Scottish Society of Arts, Transactions.
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Society of Antiquaries, Archæologia and Proceedings.
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Society of Chemical Industry, Journal.
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South Wales Institute of Engineers, Proceedings.
Tramways and Light Railways Association, Official Circular.
Victoria Institute, Journal of the Transactions.
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Amateur Photographer.
American Architect.
American Gas Light Journal.
American Machinist.
Architect.
Auto-Motor Journal.
Board of Trade Journal.
Bookseller.
Bradstreet's.
British Architect.
British Journal of Photography.
Builder.
Building News.
Cabinet Maker.
Chemical News.
Chemist and Druggist.
Chronicle (Montreal).
Chronique.
Colliery Guardian.
Contractors' Record.
Cosmos: Revue des Sciences.
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Electrical Engineer.
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Electrical Industries.
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Engineering Record (New York).
English Mechanic.
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Gardeners' Chronicle.
Graphic.
Grocer.
Indian Engineering.
Iron and Coal Trades Review.
Journal of Gas Lighting.
Journal of Horticulture.
Lancet.
Leather.
London County Council Gazette.

Machinery Market.
Master Builder.
Mechanical Engineer.
Mechanical World.
Medical Press and Circular.
Millers' Gazette.
Mining Journal.
Mining World (Chicago).
Musical Standard.
Nation.
Nature.
Notes and Queries.
Page's Weekly.
Pharmaceutical Journal.
Photography.
Practical Engineer.
Produce Markets' Review.
Public Opinion.
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Railway News.
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Royal Automobile Club Journal.
Sanitary Record.
Saturday Review.
Science.
Scientific American.
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Sphere.
Surveyor.
Textile Mercury.
Timber News.
Timber Trades Journal.
Wednesday Review (Trichinopoly).
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Fortnightly.

Agricultural News (Barbados).
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Cold Storage and Ice Trades Review.
Commercial America.
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Cooper's Vehicle Journal.
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Foundry Trade Journal.
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Gas and Oil Power.
Geographical Journal.
Giornale del Genio Civile (Rome).
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Ice and Cold Storage.
Illuminating Engineer.
Imperial Colonist.
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Investors Montoly Manual.
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